Financial Dominance and Macroeconomic Expectations

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Abstract

We study an inflationary supply shock in an economy with a high amount of private sector debt. In our framework, the central bank cannot control inflation by raising the interest rate sharply after the shock as doing so would trigger a debt crisis. It therefore follows a "backstop approach" of raising the interest rate sufficiently slowly so that the debt crisis is marginally avoided. We show that this backstop approach invites equilibrium multiplicity. Once agents expect the central bank to respond slowly to inflation, interest rate expectations fall, keeping private leverage high. As this constrains the central bank even more, inflation remains high for longer than fundamentals alone would imply. We derive these insights in a Keynesian growth model with financial frictions, calibrated to the recent Covid inflation crisis.

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1 Introduction

When private leverage is high, central banks may not be able to raise interest rates swiftly in response to inflationary shocks as this might trigger financial stress - so called financial dominance (Brunnermeier, 2016). Empirical evidence suggests that this is more likely to happen when the cause of high inflation is negative supply shocks, rather than positive demand shocks (Boissay et al., 2025). The recent Covid-related inflation and the associated monetary tightening happened against a backdrop of record-high levels of private leverage, especially in the corporate sector (Figure 1), it had a significant supply component (Guerrieri et al., 2022), and central banks, among them the Federal Reserve Bank in the US, raised interest rates with substantial delay and only timidly (Bordo et al., 2023). Did financial dominance play a role to make central banks more cautious?[1] Will the high stock of private leverage constrain monetary policy in the future?

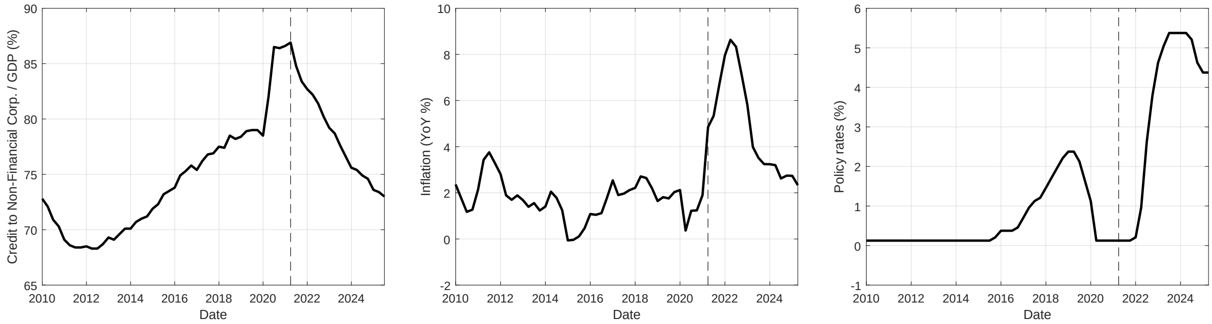
Motivated by this episode, in this paper we provide a framework to study the macroeconomic implications of financial dominance. In our framework, the central bank cannot the raise interest rate sharply following an inflationary shock as doing so would trigger a debt crisis. It therefore follows a "backstop approach" of raising the interest rate sufficiently slowly so that the debt crisis is marginally avoided. We show that this behavior by the central bank invites equilibrium multiplicity. Once agents expect the central bank to respond slowly to inflation, interest rate expectations fall, keeping private leverage high. As financial dominance persists, inflation remains high for longer than fundamentals alone would imply. We thus argue that financial dominance not only weakens monetary control over inflation, but it also allows inflation dynamics to be affected by self-fulfilling beliefs by the private sector.

We derive these insights in the context of a Keynesian growth model with financial frictions. As argued by Queralto (2019), endogenous growth models are particularly suited to model financial crises because they capture that such crises tend to be followed by long-lasting declines in output, or "scarring effects" (Cerra and Saxena, 2008; Aikman et al., 2022). To introduce a role for monetary policy, we augment the model with nominal rigidities, as in Benigno and Fornaro (2018); Fornaro and Wolf (2023). Finally, we introduce a standard macro-finance block into the model, by limiting firms' investment with a borrowing constraint and an equity friction. The main state variable in our model is debt due by firms. Our experiment consists in exposing the economy to a large negative supply shock, in a situation when firms' initial debt level is high.

We first show that, once the equity friction becomes binding, a debt crisis in our model is triggered.[2] The crisis is associated with a discontinuous adjustment in economic variables: with a

[1] A detailed account of the post-pandemic inflation surge is provided in English et al. (2024). They point to financial dominance as one of its potential drivers: "As rates moved sharply higher, however, central banks also worried that tighter policy could create financial stress – not only in the financial system, but for households, companies, and governments that had accumulated debt at floating rates under the expectations borrowing costs would remain low." Before the outbreak of Covid, the Federal Reserve was particularly worried about possible vulnerabilities emerging from the very high levels of corporate debt (FRB, 2019; Brunnermeier and Krishnamurthy, 2020). For this reason, we focus our analysis around corporate debt in the paper.

[2] Crisis dynamics are often triggered in macro-finance models once payout constraints become binding (e.g., Brunnermeier and Sannikov, 2014; Bianchi, 2016).



(a) Credit to firms. **(b) Inflation.** **(c) Policy rate.**

Figure 1: Motivating evidence. Notes: All panels refer to US data. The left panel shows total credit to non-financial corporate firms, as a share of GDP. The middle panel shows CPI inflation. The right panel shows the Fed Funds rate. The dashed vertical line indicates the peak of the credit-to-GDP ratio, on March-31 2021.

sharp decline in investment and growth, with a negative output gap (weak aggregate demand) and deflationary pressure, and with scarring effects.[3] We then show that, in our model, the emergence of a debt crisis and the stance of monetary policy are closely interlinked. When the negative supply shock hits and the central bank raises interest rates sharply, a debt crisis is triggered. However, the central bank can also avoid the debt crisis by not raising the interest rate sharply. Precisely, we show the existence of a critical interest rate in our model, so that the debt crisis is marginally avoided when the central bank sets the interest rate at this level - which Akinci et al. (2021) call the "financial instability interest rate". After a large enough negative supply shock, this critical interest lies below the natural interest rate (the one that closes the output gap), and so the central bank must accept a positive output gap if it wants to avoid the debt crisis.

We then postulate a "backstop rule" for the central bank: it sets the interest rate to minimize the output gap, but subject to the constraint that a debt crisis does not break out.[4] As argued by Boissay et al. (forthcoming), such a backstop principle describes well the actual behavior of central banks. Our main insight from the paper is that, while such a backstop rule always avoids the debt crisis, there is an important caveat: it may expose the economy to an equilibrium with self-fulfilling beliefs, in which financial dominance becomes endogenously more persistent and the supply shock triggers a much larger and more persistent response of inflation.

To understand this point, assume that the economy is hit by a *persistent* negative supply shock, i.e. one which lasts for a few periods. If the central bank were unconstrained, it would hike the interest rate sharply to close the output gap. In the "good" financial dominance equilibrium, the central bank can tighten only somewhat in the first shock period, in order to avoid a debt crisis from breaking out. However, the monetary tightening reduces private leverage over time so that, in the later phase of the shock, the central bank can raise the interest rate sufficiently to control inflation. This equilibrium can be viewed as a qualified success: the debt crisis has been avoided,

[3]Using cross-country historical data, Ivashina et al. (2024) show that financial crises often involve corporate debt, the type of debt we consider in our paper. For instance, they show that corporate debt accounts for two thirds of the aggregate credit expansion before a typical financial crisis and three quarters of total nonperforming loans during the crisis.

[4]Later on we show that our main results hold also under optimal monetary policy.

and the additional inflation due to financial dominance has been limited.

However, we show that the economy may not necessarily end up in the "good" equilibrium. Starting from the same initial conditions, the economy may also fall in the equilibrium with "animal spirits". In this equilibrium, private agents expect the central bank to be constrained by private leverage throughout the entire duration of the shock. Relative to the "good" equilibrium, this leads to a decline in interest rate expectations. Because firms' borrowing increases when interest rate expectations fall, private leverage may not decline over time.[5] But this implies that the central bank is indeed constrained by private leverage throughout the entire duration of the shock, validating the initial beliefs by the private sector. Relative to the "good" equilibrium, the implications of financial dominance are now much more dramatic, as the central bank is not able to control inflation for as long as the shock persists.

The macroeconomic implications of the two financial dominance equilibria are also very different. In the "good" equilibrium, output contracts and firms' profits and debt levels fall. In contrast, with animal spirits, the shock is almost entirely absorbed by prices, while output, profits and firm leverage grow steadily, and a debt crisis appears to be far off the equilibrium path. Interestingly, observing robust financial conditions - as has been the case during the Covid inflation crisis - is thus not necessarily proof that financial dominance has been avoided.

We show that the amount of initial leverage is an important determinant of whether or not the equilibrium with animal spirits exists. For low enough private leverage, the central bank is completely unconstrained after the shock and can close the output gap. For intermediate levels of debt, the "good" financial dominance equilibrium kicks in, but equilibrium multiplicity is not yet possible. When private leverage is even larger, the two financial dominance equilibria now coexist. We also show that the supply shock must be expected to be persistent enough for the equilibrium with animal spirits to be possible. Intuitively, because this equilibrium relies on "un-anchored" interest rate expectations, some persistence is needed to make expectations matter.

Once we calibrate our model to standard statistics of the US economy - including macro-finance statistics, such as the level and cyclicality of corporate debt - we find that corporate debt levels pre-Covid had indeed been high enough to make the equilibrium with self-fulfilling beliefs a possibility. According to our model, given the debt levels observed at the start of Covid, a negative supply shock of roughly 5% that is expected to persist for 2-3 years is enough to activate the multiplicity region. While our model is too stylized for us to take these numbers very seriously, they at least suggest that self-fulfilling beliefs of financial dominance might be a real problem in a crisis as large as Covid.

Equilibrium multiplicity in our model can be viewed as the result of a strategic complementarity. When private leverage is high, the central bank is constrained to keep the interest rate lower. Conversely, low interest rate expectations boost private leverage. Farhi and Tirole (2012)

[5] Following the evidence in Lian and Ma (2020) that most (large) U.S. firms face earnings-based borrowing constraints, we use this type of constraint in our model. A decline in interest rate expectations boosts households' aggregate demand, which in turn boosts firms' profits, leading them to borrow more. A collateral-type constraint in which an asset price appears (for instance the price of capital, as in Bianchi and Mendoza (2010)), would share this property that the borrowing constraint becomes relaxed when interest rate expectations fall.

argue that this effect can lead to self-fulfilling credit booms, where private agents leverage up in the anticipation of a future bailout through low interest rates. We focus on the same strategic complementarity, but emphasize another type of equilibrium multiplicity: in an economy that already starts highly leveraged, it may lead to multiple ways in which inflationary shocks play out due to self-fulfilling beliefs of financial dominance.

In the last part of the paper, we explore some robustness and extensions of our conclusions. We first show that, when the inflation is triggered by a positive demand shock (rather than a negative supply shock), financial dominance does not arise, independent of the extent of private leverage. This is consistent with the evidence in Boissay et al. (2025), who show that monetary tightenings after positive demand shocks are typically not associated with the emergence of financial stress. We then show that our results continue to hold once the central bank sets interest rates optimally under discretion (rather than following a backstop rule). Here we also argue that, once the equilibrium with animal spirits materializes, the welfare gains which are sometimes associated with backstop rules may be significantly eroded (Boissay et al., forthcoming). Last, we show that our results also hold when firms issue nominal debt (rather than real debt, as they do in our baseline model).

Our paper is mainly related to three strands of the literature.

First is the literature linking monetary policy and financial stability. Within this literature, we contribute to the work on financial dominance, defined as the conflict between price and financial stability that central banks face when the financial sector is highly exposed to interest rate risk and inflationary pressure arises (Brunnermeier, 2016). Brunnermeier (2023) argues that trade-offs between price and financial stability were clearly present during the Covid crisis, as the private sector had accumulated large imbalances prior to 2020 in the anticipate of future low interest rates and that central banks would ultimately backstop declines in asset prices. Boissay et al. (2023) show that private-sector leverage in advanced economies had been at an all-times high at the start of the Covid crisis. Acharya et al. (2026) build a New Keynesian model with financial dominance and show that it steepens the Phillips curve, making the central bank more willing to tolerate high rates of inflation. Akinci et al. (2021) introduce the idea of "financial instability interest rate" - the highest rate the central bank can set without triggering financial stress - and link it to the idea of financial dominance. Boissay et al. (forthcoming) argue that central banks tend to backstop stress emerging from the financial sector. Our paper highlights that financial dominance not only weakens monetary control over inflation but also raises the risk of self-fulfilling inflationary episodes driven by beliefs - implying that high private leverage can corner central banks and amplify inflationary shocks through expectational channels.[6]

Second, our paper is related to the literature unifying the study of business cycles and en-

[6] In our paper, we do not investigate the ex-ante effects that monetary policy may have on future financial stability risk, as our starting point is an economy that is already highly leveraged. Diamond and Rajan (2012) and Farhi and Tirole (2012) show that expectations of low interest rates conditional on a financial crisis occurring may induce more leverage and risk taking in tranquil times. A protracted period of low interest rates can also lead to more leverage and risk taking, see for instance Grimm et al. (2023) and Jiménez et al. (forthcoming). Schularick et al. (2021); Boyarchenko et al. (2022); Caballero and Simsek (2019); Svensson (2017); Galí (2014) study leaning against the wind policies, i.e. the idea that raising interest rates in a credit boom may be useful to make the emergence of a future financial crisis less likely.

dogenous growth. A central theme of this literature is the notion that deep recessions (such as financial crises) trigger hysteresis effects on productivity and potential output. Some examples of this literature are Fatas (2000), Comin and Gertler (2006), Benigno and Fornaro (2018), Moran and Queraltó (2018), Anzoategui et al. (2019), Queralto (2019), Garga and Singh (2020), Cozzi et al. (2021) and Queraltó (2022).[7] We build on the Keynesian growth framework introduced by Fornaro and Wolf (2023), and augment the model with financial frictions and the possibility of financial crises. We use the model to think about the implications of a spell of financial dominance for the conduct of monetary policy.

A third related literature is the one pointing out that high levels of debt can lead to macroeconomic instability in the form of multiple equilibria. This point is mostly made for sovereign debt (Calvo, 1988; Cole and Kehoe, 2000; Lorenzoni and Werning, 2019; Fornaro and Wolf, 2025; Galli, 2021), but is also arises for private debt such as debt by firms. For instance, Lamont (1995) shows that corporate debt overhang can lead to multiple equilibria, one with robust investment where debt overhang does not bind, and one with weak investment where debt overhang becomes salient. Farhi and Tirole (2012) show that self-fulfilling credit booms are possible, in which private agents leverage up, in the anticipation of a bailout through low interest rates should a financial crisis erupt.[8] We show that a high level of debt may lead to multiple ways in which inflationary shocks play out due to self-fulfilling beliefs of financial dominance. One possible interpretation of our findings is that financial dominance implies an "effective upper bound" on interest rates, and therefore naturally leads to equilibrium multiplicity in the same way as the zero lower bound leads to equilibrium multiplicity.[9] While we agree broadly with this interpretation, the challenge at establishing the result formally is that the effective upper bound is endogenous, as it depends on the evolution of private leverage. Moreover, we show that financial dominance is not sufficient for equilibrium multiplicity: in our framework, private sector leverage must be particularly large for equilibria with self-fulfilling beliefs to be possible.

The rest of the paper is structured as follows. Section 2 presents our baseline model. Section 3 studies how a debt crisis breaks out in our model, and how monetary policy can avoid this outcome by following a "backstop rule". Section 4 contains our main result: it shows the possibility of a self-fulfilling financial dominance equilibrium. Section 5 studies the robustness of our results by looking into a few model extensions, and Section 6 concludes. The Appendix contains analytical derivations and the proofs of all propositions.

[7]See Cerra et al. (2020) for a recent survey of this literature.

[8]The open economy literature has looked at self-fulfilling sudden stops, i.e. self-fulfilling contractions in foreign lending, which can happen when foreign debts are large (for instance Schmitt-Grohé and Uribe (2020) and Bianchi and Coulibaly (2023)).

[9]It is well known that the presence of the zero lower bound on interest rates makes equilibrium multiplicity possible. See, for instance, Benhabib et al. (2001), Mertens and Ravn (2014) and Benigno and Fornaro (2018).

2 A Keynesian growth model with debt crises

We study a Keynesian growth model with financial frictions. The economy consists of three agents: households, firms, and a central bank. Households consume, work, and save in bonds issued by the firms. Firms produce and invest in innovation to improve the quality of their products, which generates long-run endogenous growth. As in the macro-finance literature, firms face frictions on their ability to fund investment. When these frictions bind, a crisis emerges, in which investment and economic activity become depressed. Nominal wages are sticky, which gives the central bank room to affect the real interest rate and thereby the equilibrium of the economy. The uncertainty in the model comes from negative supply shocks.

2.1 Households

A representative household maximizes its utility from consumption

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \log(C_t) \tag{1}$$

subject to the sequence of budget constraints

$$P_t C_t + P_t \frac{B_{t+1}}{R_t} = W_t L_t + P_t D_t + P_t B_t, \tag{2}$$

where $0 < \beta < 1$ is the subjective discount factor. In the budget constraint, $P_t C_t$ is nominal expenditure on consumption, $W_t L_t$ is nominal labor income and D_t is (real) profit income that households receive from the ownership of firms. Households can save in a risk-free bond B_t at the real interest rate R_t. In equilibrium, this bond will be issued by the firms.

Our baseline model makes two simplifying assumptions which are not critical for our results but which simplify the exposition considerably. To demonstrate that those assumptions are not critical, we relax both in Section 5. First, we assume that firms issue real bonds rather than nominal bonds, which leads to a block structure between real and nominal outcomes that makes the analysis very tractable. This assumption also rules out that surprise inflation can erode the real value of firms' debt, which is potentially an important mechanism. In Section 5 we show that our main insights are preserved in this case. Second, we introduce the Keynesian block into the model in a particularly simple way. We first assume that households' voluntary labor supply is exogenous and fixed at 1. We then posit a simple reduced-form wage Phillips curve to introduce wage stickiness (see below). As is typical in models with wage stickiness, households may not supply their voluntary hours in equilibrium, because equilibrium employment is dictated by aggregate demand.

With the labor supply choice fixed at 1, households' remaining decision is how much to consume versus how much to save. This leads to the conventional Euler equation

$$\frac{1}{C_t} = \beta R_t \mathbb{E}_t \frac{1}{C_{t+1}}. \tag{3}$$

2.2 Final good production

The final good is produced by competitive firms using labor and a continuum of measure one of intermediate inputs $x_{j,t}$, indexed by $j \in [0, 1]$. Denoting by Y_t the output of the final good, the production function is

$$Y_t = (Z_t L_t)^{1-\alpha} \int_0^1 A_{j,t}^{1-\alpha} x_{j,t}^{\alpha} \mathrm{d}j, \tag{4}$$

where $0 < \alpha < 1$, and where $A_{j,t}$ captures the productivity, or quality, of input j. Z_t, instead, is an exogenous component of labor productivity, and captures the "supply shock" in our model. This term captures all the transitory factors affecting labor productivity which are not directly linked to firms' investment. For instance, a reduction in Z_t could capture an exogenous increase in the price of some key production inputs which are complementary to labor, such as energy. Our motivation to focus on supply shocks is empirical: Boissay et al. (2025) show that monetary tightenings tend to trigger financial stress after negative supply shocks, but not so after positive demand shocks. We will show in Section 5 that this is also true in our model.

Profit maximization implies the demand functions

$$P_t (1 - \alpha) Z_t^{1-\alpha} L_t^{-\alpha} \int_0^1 A_{j,t}^{1-\alpha} x_{j,t}^{\alpha} \mathrm{d}j = W_t \tag{5}$$

$$\alpha P_t (Z_t L_t)^{1-\alpha} A_{j,t}^{1-\alpha} x_{j,t}^{\alpha-1} = P_{j,t} \tag{6}$$

where $P_{j,t}$ is the nominal price of intermediate input j. Due to perfect competition, firms in the final good sector do not make any profit in equilibrium.

2.3 Intermediate good production and profits

Every intermediate good is produced by a single monopolist. One unit of final output is needed to manufacture one unit of the intermediate good, regardless of quality. In order to maximize profits, each monopolist sets the price of its good according to $P_{j,t}/P_t = 1/\alpha$. In words, each monopolist charges a constant markup $1/\alpha > 1$ over its marginal cost. Combining with equation (6) implies that the quantity produced of a generic intermediate good j is

$$x_{j,t} = \alpha^{\frac{2}{1-\alpha}} A_{j,t} Z_t L_t. \tag{7}$$

Combining equations (4) and (7) gives equilibrium gross output

$$Y_t = \alpha^{\frac{2\alpha}{1-\alpha}} A_t Z_t L_t, \tag{8}$$

where $A_t \equiv \int_0^1 A_{j,t} dj$ is an index of average productivity. Hence, production of the final good is increasing in the average level of productivity, in the exogenous component of labor productivity, and in the amount of labor employed in production.

In addition to the variable cost, we assume that the production of intermediate goods entails a fixed cost $A_t\nu \geq 0$. To ensure existence of a balanced growth path, we assume that the fixed cost scales with the average level of productivity A_t. As we argue below, the fixed cost implies that firms' profits are more volatile than GDP, and that both the profits-to-GDP ratio and the debt-to-GDP ratio are pro-cyclical. All these are features of the data and matching them is important for us, because the debt crisis will be triggered by a decline in firms' profits and subsequent deleveraging.

The real profits earned by the monopolist in sector j are then given by

$$\left(\frac{P_{j,t}}{P_t} - 1\right) x_{j,t} - A_t\nu = \varpi A_{j,t} Z_t L_t - A_t \nu, \tag{9}$$

where $\varpi \equiv (1/\alpha - 1)\alpha^{2/(1-\alpha)}$. According to this expression, the producer of an intermediate input of higher quality earns higher profits. Moreover, profits are increasing in $Z_t L_t$ due to the presence of a market size effect. Intuitively, high production of the final good is associated with high demand for intermediate inputs, leading to high profits in the intermediate sector.

2.4 Firm financing and investment in innovation

Firms operating in the intermediate sector can invest in innovation in order to improve the quality of their products. In particular, a firm that invests $I_{j,t}$ units of the final good sees its productivity evolve according to

$$A_{j,t+1} = \rho A_{j,t} + \chi I_{j,t}^{\varphi} A_t^{1-\varphi} \tag{10}$$

We allow for decreasing returns to investment to capture congestion effects or adjustment costs in the innovation process, through the parameter $0 < \varphi \leq 1$. Moreover, knowledge obsolescence is captured by $0 < \rho \leq 1$ and $\chi > 0$ captures the productivity of investment.

Firms choose investment in innovation to maximize the discounted stream of real profits net of investment costs. Specifically, firms maximize the value

$$V_{j,t} = (1 + \gamma \mathbb{1}_{D_{j,t}<0}) D_{j,t} + \beta \mathbb{E}_t \frac{C_t}{C_{t+1}} V_{j,t+1} \tag{11}$$

subject to the law of motion for technology (10), where real dividends $D_{j,t}$ are given by

$$D_{j,t} = \varpi A_{j,t} Z_t L_t - \nu A_t - \tau \left(\varpi A_{j,t} Z_t L_t - \nu A_t - \left(1 - \frac{1}{R_t}\right) B_{j,t+1}\right) + \frac{B_{j,t+1}}{R_t} - B_{j,t} - I_{j,t} + T_{j,t}. \tag{12}$$

The first term on the right-hand side of (12) captures firms' profits. The second term shows that firms must pay a proportionate tax τ on their profits. Importantly, the interest payments that firms make on their debt are tax-deductible. Following Hennessy and Whited (2005) and many others, we thus assume that firms rely on debt financing because it offers tax advantages.[10] The

[10] With $\tau = 0$, firms are indifferent between debt and equity finance, and their level of borrowing is not pinned down (Modigliani and Miller, 1958).

final term $T_{j,t}$ captures lump-sum rebates received from the government. This term is given by

$$T_{j,t} = \tau \left(\varpi A_{j,t} Z_t L_t - \nu A_t - \left(1 - \frac{1}{R_t}\right) B_{j,t+1} \right), \tag{13}$$

which implies that the firms' income is unaffected by the profit tax in equilibrium.

Firms are subject to two financial frictions. The first one is that issuing equity is costly, which shows up in the value of the firm (11). Specifically, when firms pay negative dividends (raise equity), so that $D_{j,t} < 0$, they must pay a cost $\gamma > 0$ per unit of equity raised. Of course, an equity friction is needed in a model with borrowing constraints, as otherwise firms could simply undo the borrowing constraint by relying on equity injections.[11]

Second, firms are also constrained in their ability to borrow. We assume that

$$B_{j,t+1} \leq \kappa \left(\varpi A_{j,t} Z_t L_t - \nu A_t \right), \tag{14}$$

so that firms can borrow at most a multiple $\kappa > 0$ of their current-period earnings. Lian and Ma (2020) show that earnings-based constraints are the dominant form of debt limits in the US, and Drechsel (2023) shows that a model with earnings-based constraints captures better US investment and corporate debt dynamics, compared to a model with asset-based constraints.[12]

Denoting $\lambda_{j,t}$ the Lagrange multiplier on the budget constraint, and $\iota_{j,t} \geq 0$ the non-negative Lagrange multiplier on the borrowing constraint, the first order conditions for dividends and borrowing are given by[13]

$$\lambda_{j,t} = \begin{cases} 1 & \text{if } D_{j,t} > 0 \\ [1, 1+\gamma] & \text{if } D_{j,t} = 0 \\ 1+\gamma & \text{if } D_{j,t} < 0. \end{cases} \tag{15}$$

$$\lambda_{j,t} \frac{1 + \tau(R_t - 1)}{R_t} = \beta \mathbb{E}_t \frac{C_t}{C_{t+1}} \lambda_{j,t+1} + \iota_{j,t} \tag{16}$$

as well as the complementary slackness condition

$$\iota_{j,t}(B_{j,t+1} - \kappa(\varpi A_{j,t} Z_t L_t - \nu A_t)) = 0. \tag{17}$$

Equation (15) shows that the value of internal funds $\lambda_{j,t}$ is equal to 1, unless the firm touches the equity issuance region in which case the value of internal funds rises above 1. In this case,

[11] A linear cost function is standard in the literature (for instance Falato et al. (2022)). A convex cost function would yield very similar results.

[12] According to Lian and Ma (2020), more than 80% of US non-financial firms' lending is backed by earnings (cash flow), rather than by collateral. Our main result (the fact that multiple financial-dominance equilibria may exist) would, however, also survive with a collateral-type borrowing constraint. As we explain below, what matters for this result is that the borrowing constraint becomes less tight once interest rate expectations decline. This also happens with collateral-type borrowing constraints.

[13] Since the dividend decision is subject to non-differentiability at zero, we show how to derive the expression for $\lambda_{j,t}$ in Appendix A. Note the slight abuse of notation in the case of $D_{j,t} = 0$, which means that $\lambda_{j,t}$ may take any value in the interval.

therefore, internal funds are more valuable compared to external funds. Equation (16) is the Euler equation for firms' borrowing. We can see how the tax shield tends to push firms against the borrowing constraint. Assume, for instance, that $\lambda_{j,t+1} = 1$ so that the equity constraint is expected to be slack in the next period. Combining with households' Euler equation (3), we can see that $\iota_{j,t} = \lambda_{j,t}(1 + \tau(R_t - 1))$, so that firms are pushed against the borrowing constraint ($\iota_{j,t} > 0$) whenever the real interest rate is positive ($R_t > 1$, which in equilibrium will always be the case). Conversely, the only reason for firms to stay away from the borrowing constraint is the expectation of a binding equity constraint in the next period ($\lambda_{j,t+1} > 1$).

The first order condition for investment is given by

$$\lambda_{j,t}\frac{1}{\varphi\chi}\left(\frac{I_{j,t}}{A_t}\right)^{1-\varphi}$$
$$= \beta\mathbb{E}_t\frac{C_t}{C_{t+1}}\left(\lambda_{j,t+1}\left((1-\tau)\varpi Z_{t+1}L_{t+1} + \rho\frac{1}{\varphi\chi}\left(\frac{I_{j,t+1}}{A_{j,t+1}}\right)^{1-\varphi}\right) + \iota_{j,t+1}\kappa\varpi Z_{t+1}L_{t+1}\right). \quad (18)$$

The left-hand side of this expression captures the marginal costs of investment, the right-hand side captures the benefits. When the innovation technology is concave ($\varphi < 1$), the costs are decreasing in the innovation intensity $I_{j,t}/A_t$. Moreover, when the equity constraint binds so that the value of internal funds goes up ($\lambda_{j,t} > 1$), this also pushes up the costs of investment. The marginal benefits consist of the additional profits that investment generates in the next period plus the continuation value (the saving of future research costs). Finally, the last term on the right-hand side captures the fact that investment today relaxes next period's borrowing constraint, through an increase in next period's profits.

2.5 Nominal rigidities

We consider an economy with frictions in the adjustment of nominal wages.[14] The presence of nominal wage rigidities plays two roles in the model. First, it implies that output and employment can deviate temporarily from their "natural" levels. Second, it implies that monetary interventions have real effects, by allowing the central bank to affect the real interest rate in the economy.

Following Fornaro and Wolf (2023), in our baseline model we introduce nominal wage rigidity by positing the following reduced-form wage Phillips curve

$$\frac{W_t}{W_{t-1}} = gL_t^{\xi_l}\Pi_{t-1}^{\xi_\pi}, \quad (19)$$

where $\xi_l > 0$, $0 \leq \xi_\pi < 1$ are parameters and Π_{t-1} denotes lagged gross price inflation. According to this equation, as in standard Phillips curves, an increase in employment above its natural level (which we normalized to 1) puts upward pressure on wage growth. Moreover, when $\lambda > 0$ wages

[14] A growing body of evidence emphasizes how nominal wage rigidities represent an important transmission channel through which monetary policy affects the real economy. For instance, this conclusion is reached by Olivei and Tenreyro (2007), who show that monetary policy shocks in the US have a bigger impact on output in the aftermath of the season in which wages are adjusted. Micro-level evidence on the importance of nominal wage rigidities is provided, for instance, by Fehr and Goette (2005), Gertler et al. (2020) and Hazell and Taska (2025).

are partially indexed to past price inflation. While not crucial for our results, this feature is helpful to obtain reasonable inflation dynamics in response to inflationary shocks. Finally, we normalize wage inflation in the full employment steady state to be equal to steady state productivity growth, denoted by g.

Using the wage-setting rule (19), as well as (5) and (7), we get an expression for price inflation $\Pi_t \equiv P_t/P_{t-1}$

$$\Pi_t = \frac{g}{g_t}\frac{Z_{t-1}}{Z_t}L_t^{\xi_l}\Pi_{t-1}^{\xi_\pi}. \tag{20}$$

Intuitively, firms set prices equal to their marginal cost. Higher wage inflation puts upward pressure on marginal costs and leads to higher price inflation, while faster productivity growth reduces marginal costs and lowers price inflation. This explains why price inflation is increasing in employment, and decreasing in productivity growth. The term $\Pi_{t-1}^{\xi_\pi}$ captures the inflation persistence arising from the indexation of wages.

2.6 Aggregation and market clearing

Market clearing for the final good implies[15]

$$Y_t - \int_0^1 x_{j,t}dj - A_t\nu = C_t + I_t, \tag{21}$$

where $I_t \equiv \int_0^1 I_{j,t}dj$ is aggregate investment. The left-hand side of this expression is the GDP of the economy, while the right-hand side captures the fact that all the GDP has to be either consumed or invested.

Using equations (7) and (4) we can write GDP as

$$Y_t - \int_0^1 x_{j,t}dj - A_t\nu = \Psi A_t Z_t L_t - A_t\nu, \tag{22}$$

where $\Psi \equiv \alpha^{2\alpha/(1-\alpha)}(1-\alpha^2)$.

Long-run growth in this economy takes place through increases in the quality of the intermediate goods, captured by increases in the productivity index A_t. We can thus think of $g_t \equiv A_t/A_{t-1}$ as

[15] The goods market clearing condition can be derived by combining the households' budget constraint with the expression for firms' profits

$$D_t = \underbrace{Y_t - \frac{W_t}{P_t}L_t - \frac{1}{\alpha}\int_0^1 x_{j,t}dj}_{\text{profits from final goods sector}} + \underbrace{\int_0^1\left(\frac{1}{\alpha}-1\right)x_{j,t}dj - \nu A_t - \int_0^1 I_{j,t}dj}_{\text{profits from intermediate goods sector}}.$$

Here we assume that the dividend cost γ is a cost that firms pay to the households. This implies that γ drops out when aggregating their two budget constraints. In contrast, we assume that the fixed cost ν is a real resource cost, and therefore it subtracts from profit income.

the trend component of productivity. Using this definition, we can write equation (10) as[16]

$$g_{t+1} = \rho + \chi \left(\frac{I_t}{A_t} \right)^{\varphi}. \tag{23}$$

This expression implies that higher investment in period t is associated with faster productivity growth between periods t and $t+1$.

2.7 Summary of equilibrium conditions

In what follows, we use lower case letters to denote upper case ones divided by productivity, i.e. $x_t \equiv X_t/A_t$, for a generic variable X_t. The equilibrium of the economy can then be described by the following set of equations.

The first equation captures consumers' consumption and savings behavior. It is obtained by rewriting the Euler equation (3) as

$$\frac{1}{c_t} = \beta R_t \frac{1}{g_{t+1}} \mathbb{E}_t \frac{1}{c_{t+1}}. \tag{24}$$

As it is standard, this equation implies that current demand for consumption is increasing in future (normalized) consumption and decreasing in the real interest rate. It also implies a positive relationship between trend productivity growth and present demand for consumption. The reason is that faster productivity growth is associated with higher future incomes, which raises consumption demand through a positive wealth effect.

The second one is the resource constraint

$$\Psi Z_t L_t - \nu = c_t + \left(\frac{g_{t+1} - \rho}{\chi} \right)^{\frac{1}{\varphi}}, \tag{25}$$

where we have replaced investment I_t by using equation (23). This equation shows that GDP goes to consumption and investment.

The third equation is firms' investment condition, which pins down growth in the economy

$$\begin{aligned} &\left(\frac{g_{t+1} - \rho}{\chi} \right)^{\frac{1-\varphi}{\varphi}} \frac{1}{\varphi \chi} \lambda_t \\ &= \mathbb{E}_t \beta \frac{c_t}{g_{t+1} c_{t+1}} \left(\lambda_{t+1} \left((1-\tau) \varpi Z_{t+1} L_{t+1} + \rho \left(\frac{g_{t+2} - \rho}{\chi} \right)^{\frac{1-\varphi}{\varphi}} \frac{1}{\varphi \chi} \right) + \iota_{t+1} \kappa \varpi Z_{t+1} L_{t+1} \right). \end{aligned} \tag{26}$$

We obtained this equation by rewriting firms' investment first order condition (18). It shows that growth declines when (expected) profits decline, when the real interest rate rises (the dependence on households' discount factor), or when the value of internal funds rises ($\lambda_t > 1$).

[16] To derive this equation we focus on a symmetric equilibrium, where $I_{j,t} = I_t$ and $A_{j,t} = A_t$ for all j. This equilibrium arises naturally once we assume symmetric initial conditions. Because firms face no risk at the individual level, this symmetry will prevail over time because firms make identical decisions.

The next equation is the flow of firms' borrowing

$$d_t = \varpi Z_t L_t - \nu + \frac{b_{t+1} g_{t+1}}{R_t} - b_t - \left(\frac{g_{t+1} - \rho}{\chi} \right)^{\frac{1}{\varphi}}. \tag{27}$$

This equation shows that firms' dividends decline when their profits decline, when they (are forced to) deleverage, when the interest rate - growth differential rises, and when they invest more.

The next equation pins down firms' borrowing choice, equation (16)

$$\lambda_t \frac{1 + \tau(R_t - 1)}{R_t} = \mathbb{E}_t \beta \frac{c_t}{c_{t+1} g_{t+1}} \lambda_{t+1} + \iota_t. \tag{28}$$

The value of internal funds, i.e. the multiplier λ_t, is determined by the condition

$$\lambda_t = \begin{cases} 1 & \text{if } d_t > 0 \\ [1, 1 + \gamma] & \text{if } d_t = 0 \\ 1 + \gamma & \text{if } d_t < 0. \end{cases} \tag{29}$$

Finally, the model is closed with the following inequality and complementary slackness conditions:

$$b_{t+1} \leq \kappa \frac{\varpi L_t Z_t - \nu}{g_{t+1}} \tag{30}$$

$$\iota_t \geq 0 \tag{31}$$

$$\iota_t \left(b_{t+1} - \kappa \frac{\varpi L_t Z_t - \nu}{g_{t+1}} \right) = 0. \tag{32}$$

An equilibrium consists of real allocations $\{b_{t+1}, g_{t+1}, c_t, L_t, d_t\}_t$ and multipliers $\{\lambda_t, \iota_t\}_t$ which satisfy these conditions, for given monetary policy $\{R_t\}_t$ and the supply shock series $\{Z_t\}_t$. Here we have specified monetary policy as choosing a path for the real interest rate directly, rather than the nominal one. Doing so simplifies the analysis because our model has a block structure. For a given real interest rate path, the real side of the economy is independent from the nominal side. Indeed, inflation dynamics are pinned down as a residual from the Phillips curve (20). This also implies that for a given real interest rate path, the precise shape of the Phillips curve, i.e. of the underlying nominal rigidity, is irrelevant for the allocation.[17]

2.8 Steady state

We use variables without a time subscript to denote the steady state (or balanced growth path) of a variable. We focus on the full employment steady state, where households work their voluntary number of hours, $L = 1$. Moreover, we normalize the supply shock to one in steady state, $Z = 1$.

We pick parameters so that $d > 0$ in steady state, so that firms issue a positive amount of dividends in every period. The equity friction is therefore slack, and so the value of internal funds

[17] This block structure breaks down when nominal variables matter directly for the allocation. This happens, for instance, when firms issue nominal debt, a case which we analyze in Section 5.

is $\lambda = 1$. Combining households' Euler equation for saving and firms' one for borrowing, we can see that this implies $\iota > 0$. That is, the borrowing constraint binds in steady state. Replacing ι in the growth equation, g is defined implicitly by

$$\left(\frac{g-\rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}} \frac{1}{\varphi\chi} g = \beta \left(\left((1-\tau)\varpi + \rho \left(\frac{g-\rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}} \frac{1}{\varphi\chi} \right) + \tau \left(1 - \frac{\beta}{g}\right) \kappa\varpi \right).$$

Finally, once growth is determined, the steady state debt level follows from

$$b = \kappa \frac{\varpi - \nu}{g}$$

and steady state dividends are

$$d = \varpi - \nu - b(1-\beta) - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}.$$

We assume that the borrowing capacity κ, and therefore the debt level b, are low enough in steady state so that firms can finance the debt service out of their profits. This ensures that dividends are indeed positive in steady state.

3 Avoiding a debt crisis

We now study how an economy that is initially highly leveraged responds to an inflationary supply shock, and how this depends on the monetary response to the shock. Because our focus is on financial dominance, we do not study run-up dynamics and how monetary policy may influence *ex-ante* incentives to leverage up, which has been studied by a previous literature (cited in the introduction). Instead, and in light of our motivational Figure 1, we take a high stock of private leverage at the starting point of our experiment simply as given.

Specifically, throughout the paper, we consider the following experiment. The economy is initially in steady state, when a previously unexpected negative supply shock hits in period 0. The supply shifter falls to the level $Z_0 = z < 1$. It then stays at this level in the next period with probability p, and it reverts to its steady state level of 1 with probability $1 - p$. Once the shock dissipates, all uncertainty is resolved and the economy moves back to its steady state.[18]

We start by showing that our model generates debt crisis, i.e. discontinuous, sharp adjustments in economic variables, once the equity issuance friction binds. We also show that the crisis is triggered once the shock is large enough and the central bank hikes the interest rate in an attempt to close the output gap and to prevent inflation. Conversely, this also means that the central bank can always avoid the debt crisis by not stabilizing inflation fully after the shock.

[18] This shock structure is very useful to obtain analytical insights (Woodford, 2011). Our results can be generalized to an AR(1) shock structure which is more common in quantitative analyses.

3.1 Financial instability interest rate and debt crisis

We start by deriving the response of the economy to a purely transitory negatively supply shock ($p = 0$).

We first compute the growth rate in response to the shock, as a function of the central bank's response to the shock R_0. Combining households' Euler equation (24) and the growth equation (26), assuming that dividends are still positive ($d_0 > 0$) so that $\lambda_0 = 1$, and using that all future variables are in steady state, we get[19]

$$g_1 = \rho + (g - \rho) \left(\frac{R}{R_0} \right)^{\frac{\varphi}{1-\varphi}} . \tag{33}$$

The growth rate is not affected by the shock itself, as z does not appear in this equation. However, to the extent that the central bank raises its interest rate above the steady state in response to the shock ($R_0 > R$), we can see that growth declines below its steady state value ($g_1 < g$), with elasticity $\varphi/(1 - \varphi)$. Intuitively, of course growth declines because a higher interest rate depresses firms' investment.

Using this result, and using households' Euler equation (24) to substitute out c_0, we can compute GDP in the shock period by using the resource constraint (25)

$$\Psi z L_0 - \nu = \frac{R}{R_0} \left(\rho + (g - \rho) \left(\frac{R}{R_0} \right)^{\frac{\varphi}{1-\varphi}} \right) \frac{c}{g} + \left(\frac{g - \rho}{\chi} \right)^{\frac{1}{\varphi}} \left(\frac{R}{R_0} \right)^{\frac{1}{1-\varphi}} . \tag{34}$$

GDP is the sum of consumption demand (first term on the right-hand side) and investment demand (second term on the right-hand side). Consumption demand is decreasing in R_0 for two reasons: first, because of intertemporal substitution, but also second, because a rise in R_0 reduces future growth, which reduces present consumption through a negative wealth effect. Investment demand is also decreasing in R_0, as mentioned above.

Because nominal wages are rigid, by controlling aggregate demand, the central bank controls GDP and therefore employment L_0 from equation (34), for a given shock size z. In particular, when $z < 1$, then $L_0 > 1$ (the output gap becomes positive) once the central bank keeps the interest rate and therefore aggregate demand in steady state ($R_0 = R$). Of course, this happens because the same aggregate demand meets a lower aggregate supply, and so labor must increase to absorb the imbalance. To close the positive output gap, the central bank must therefore hike the interest rate above its steady state value, and the more so, the larger is the shock. We denote the interest rate which closes the output gap ($L_0 = 1$) by R^n ("natural"), and note that $R^n(z)$ is a declining function of z.

We next look at the implications for dividends. Dividends are interesting to look at because, as we show below, what triggers debt crises in our model is that the equity issuance friction becomes

[19] While the economy has an endogenous state variable, namely firms' debt b_t, it still reverts to its steady state within one period following a transitory negative supply shock. This happens because the equity friction is not binding in the recovery phase after the shock.

binding (i.e., dividends turn negative). Using equation (27), the fact that the borrowing constraint (30) binds when the shock is in place, and equation (34), we get

$$d_0 = (\varpi z L_0 - \nu)\left(1 + \kappa \frac{\beta}{g}\frac{R}{R_0}\right) - b_0 - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}} \left(\frac{R}{R_0}\right)^{\frac{1}{1-\varphi}}. \tag{35}$$

We can see that dividends decline in the interest rate R_0, for three reasons. First, firms' profits fall due to lower employment (as we just showed, L_0 declines in R_0). Second, lower profits imply that firms borrow less, lowering cash flow. Third, for a given volume of borrowing, the amount of resources raised is lower when the interest rate is higher.[20] We can also see that, when the central bank sets the steady state interest rate and therefore keeps aggregate demand and GDP in steady state, dividends remain likewise in steady state (and are therefore positive).

In our model, the central bank can thus always avoid that dividends turn negative, and therefore that a debt crisis erupts, by not raising the interest rate too much after the shock. Conversely, when a debt crisis breaks out, it is because the central bank has raised the interest rate by so much that dividends turn negative. We denote the highest possible interest rate for which a crisis does not erupt by R^d (where d stands for "dividends") - which Akinci et al. (2021) call the "financial instability interest rate". That is, $R^d > R$ is the level of interest rates which solves equation (35) to zero.[21] Notice that, unlike R^n, R^d is not a function of z. This can be seen by writing firms' profits as $\frac{\varpi}{\Psi}\Psi z L_0$, and substituting out $\Psi z L_0$ using equation (34).

For as long as $R^n(z) < R^d$, which is true as long as the shock is small enough (z is high enough), there is no conflict of interest between price stability and financial stability. The central bank can close the output gap by raising the interest rate, and this will not interfere with the equity friction. But because $R^n(z)$ rises as z declines, at some point it will intersect R^d. We denote the critical shock size by Z^d, which is such that $R^n(Z^d) = R^d$. Assume that from this point onward, the central bank will not hike the interest rate further. As it is easy to see, the central bank will then have to live with the positive output gap

$$L_0 = \frac{Z^d}{z} > 1. \tag{36}$$

But imagine now that the central bank hikes the interest rate further, above the level R^d. Specifically, assume that the central bank sets the interest rate to the level $R_0 = R^d + \varepsilon$, with $\varepsilon \to 0$. As the following proposition shows, this marginal increase in the interest rate will trigger a debt crisis, once a specific parametric condition is met. The proposition also uses the variable g^d,

[20] There is also a fourth, countervailing channel. As firms invest less when the interest rate is higher, this frees up cash flow and increases the dividend (the last term in (35)). In Appendix B, we show that R^d, which we define below, always exist, even if dividends are not strictly decreasing in R_0 everywhere.

[21] Strictly speaking, in our model self-fulfilling crises can occur in a range of interest rates below R^d. If expectations coordinate on low growth, aggregate demand collapses which turns dividends negative. Due to the high cost of equity financing, firms cut back investment, ex-post validating the expectation of low growth. We follow Boissay et al. (forthcoming) by assuming that only fundamental crises occur, i.e. an equilibrium with $d_0 < 0$ is only selected when no other equilibrium exists. This is the most conservative assumption with respect to the role of financial dominance. Under a different equilibrium selection mechanism, an even lower interest rate would be needed to rule out financial crises.

which we define as (33) evaluated at R^d, i.e. the growth rate in the shock period when the central bank sets $R_0 = R^d$ exactly.

Proposition 1 *Consider a purely transitory negative supply shock. Assume that $z < Z^d$, and that $R_0 = R^d + \varepsilon$, with $\varepsilon \to 0$. Consider the following parametric condition*

$$\frac{\varpi}{\Psi z}\left(1+\kappa\frac{\beta}{R^d}\right)\left(\frac{c}{\beta R^d}+\frac{1}{\varphi\chi}\left(\frac{g^d-\rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}}\right) > \frac{1}{\varphi\chi}\left(\frac{g^d-\rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}}. \tag{37}$$

When condition (37) holds, growth is given by

$$g_1 = \rho + (g-\rho)\left(\frac{1}{1+\gamma}\frac{R}{R^d}\right)^{\frac{\varphi}{1-\varphi}} < g^d, \tag{38}$$

the dividend is $d_0 < 0$, and the output gap is strictly below Z^d/z, and even negative when γ is large enough ($L_0 < 1 < Z^d/z$).

To understand Proposition 1, consider what happens when the central bank raises slightly the interest rate above R^d, implying that the equity issuance friction becomes binding. As the interest rate moves above R^d, individual firms respond by cutting investment in order to avoid having to issue costly equity. This behavior at the micro level sets off a general equilibrium effect. Lower investment translates into lower aggregate demand, for two reasons. First, the decline in investment demand reduces aggregate demand directly. Second, consumption demand likewise declines when growth is lower, due to a negative wealth effect. The two channels combined imply that employment is now lower, driven by lower aggregate demand. Because firms' profits depend on aggregate demand through employment, this pushes them even harder against the equity constraint, leading to amplification.[22]

When condition (37) fails, the general equilibrium effect is sufficiently weak that firms can successfully free up cash flow by reducing their investment and stay away from the equity constraint. This implies that the response of the economy to the marginal rise in interest rates is continuous, so that a debt crisis does not erupt. In fact, when condition (37) fails, growth after the marginal rate hike is simply given by g^d, the dividend is $d_0 = 0$, and the output gap is $Z^d/z > 1$, as in the case where the central bank sets $R_0 = R^d$ exactly.

When condition (37) holds, however, the general equilibrium effect is so strong that firms' attempts to free up cash flow are self-defeating in general equilibrium. A debt crisis now erupts, and variables jump discontinuously in response to a marginal rise in interest rates. At the end of the amplification loop, firms accept that equity issuance is unavoidable, and investment and growth are lower reflecting that the required return on investment is higher, to compensate for the rise in the value of internal funds triggered by equity issuance ($\lambda_0 = 1+\gamma$). The fact that

[22]This amplification cycle is reminiscent of the analysis in Benigno and Fornaro (2018), but plays out here in the context of a debt crisis. At the heart of it is an aggregate demand externality because agents do not internalize that, by reducing their demand in face of nominal rigidities, this reduces other agents' incomes (Schmitt-Grohé and Uribe, 2016; Farhi and Werning, 2016). We expand on this point in the proof of Proposition 1, in Appendix B.

aggregate demand is weak also explains why the debt crisis is associated with a sharp reversal in the output gap, which can even become negative (see Proposition 1).

We have thus established that debt crises may arise in our model. Moreover, we have shown that the emergence of a crisis and the monetary stance are closely interlinked. In our framework, a debt crisis is not a mechanical consequence of a sufficiently negative supply shock, but a result of the central bank's attempt to close the output gap and to prevent inflation in response to the shock. Conversely, this also means that the central bank can always avoid the debt crisis, by keeping the interest rate below the rate R^d and accepting inflation.

We can refine this conclusion by recognizing that R^d depends on the amount of outstanding debt b_0. As we can see in equation (35), dividends are smaller when initial debt levels are larger, which implies that R^d declines in b_0. For future reference, we write this as a function $R^d(b_0)$, which is strictly downward sloping. In words, the economy is less able to tolerate a rate hike without this leading to crisis when initial leverage is higher. This model property squares well with the idea that central banks become more constrained when debt levels are higher, i.e. financial dominance becomes stronger in this case.

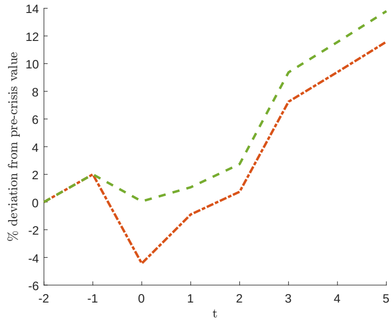
3.2 Crisis dynamics

We next illustrate our results numerically, by focusing on a persistent shock ($p > 0$). To do so, we calibrate our model to the US economy before the outbreak of Covid.

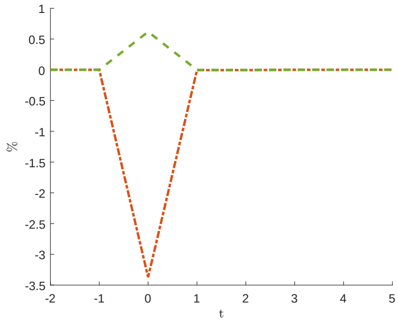
The length of a period is one year. We target a steady state growth rate and real interest rate of 2% and 4%, respectively. Given the other parameters, this yields an efficiency of research of $\chi = 0.82$ and, from $g = \beta R$, a discount factor of $\beta = 0.98$. To pin down the curvature of the innovation technology, we use the evidence of Ma and Zimmermann (2023) that a 1 percentage point increase in the interest rate reduces innovation investment by 1 - 3%. Setting $\varphi = 0.4$ yields a semi elasticity of 2%, in the middle of these estimates. We set $\rho = 0.85$ to capture a yearly obsolescence of knowledge of 15%, in line with the depreciation of the R&D stock estimated by the Bureau of Labor Statistics. We set $\tau = 0.25$ to capture a corporate tax rate of 25%. We target a steady state dividend share of GDP of 5%, which yields $\alpha = 0.33$. We set $\kappa = 5$ and $\nu = 0.45$ to target jointly the level and volatility of the corporate debt-to-GDP ratio. Specifically, we target a steady state corporate debt-to-GDP ratio of 80% and a typical boom-bust cycle of ± 10 percentage points, roughly consistent with data in FRB (2019).[23] We choose $\gamma = 0.2$ to match a decline in TFP by 2% during a financial crisis, in the range of numbers reported by Boissay et al. (forthcoming). To calibrate the Phillips curve, we follow Fornaro and Wolf (2023) and set $\xi_\pi = 0.5$ for inflation persistence, and we set $\xi_l = 0.65$ for the response of inflation to the output gap, a choice which we motivate in Appendix D where we study a micro-founded Phillips curve.

Because of the possibility of debt crises - which are discontinuous events - our model cannot be solved using local approximation. Instead we solve the model globally, by using an algorithm

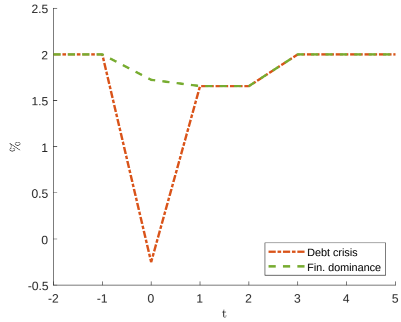
[23] Our choice of κ lies at the upper end of the distribution reported in Lian and Ma (2020), and we report robustness to this choice in Section 4.3.



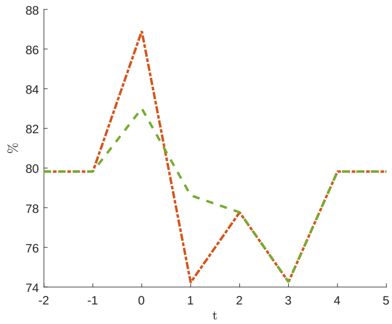
(a) Output



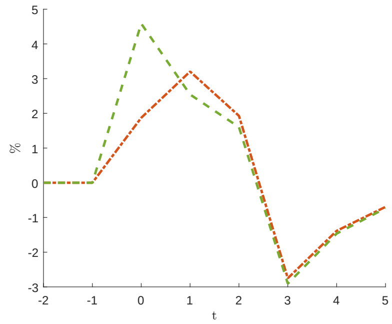
(b) Output gap



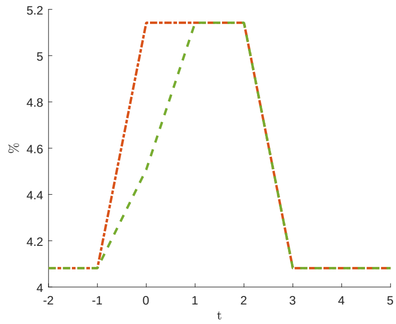
(c) Growth



(d) Debt to GDP



(e) Inflation



(f) Real interest rate

Figure 2: Crisis dynamics after negative supply shock.

that can handle occasionally binding constraints.

Figure 2 shows how the economy responds to a persistent negative supply shock. We assume that $z = 0.96$, i.e. the exogenous component of labor productivity falls by four percent, and $p = 0.7$, so that the shock is expected to last for around 3 years. While the date at which the shock reverts is uncertain for agents inside the model, we assume that the reversal realizes in period 3.

Figure 2 shows two experiments. Focus first on the green dashed lines ("financial dominance"). As it is standard, the negative supply shock triggers an output drop and at the same time a rise in inflation. The rise in inflation reflects that nominal wages are sticky, and so the decline in labor productivity triggered by the shock must be absorbed by higher prices (Blanchard and Galí, 2007; Fornaro and Wolf, 2023). To avoid that a positive output gap opens up, the central bank hikes the real interest rate. However, it is constrained in its ability to do so, because of high private leverage. Specifically, the central bank hikes the interest rate by as much as this is possible without triggering a debt crisis (in the language of the previous section, it sets the interest rate to R^d). But that is not enough to close the output gap, which is positive in the initial shock period. The central bank is, in other words, "behind the curve". In the second shock period, however, the central bank does manage to close the output gap. This is possible because leverage has declined after the first shock period, driven by the monetary tightening (and the anticipation of the future tightening, as we argue in the next section). In the language of the previous section, R^d has shifted up because of lower leverage, enabling the central bank to raise the interest rate further and finally close the output gap.

Turn now to the second experiment, in red dashed lines ("debt crisis"). In this experiment, the central bank hikes the interest rate even more in the first shock period, in an attempt to close the positive output gap. We can see that this attempt to close the output gap fails spectacularly. Rather than stabilize the economy, the additional monetary tightening triggers a debt crisis. The growth rate declines sharply, and the output gap turns from strictly positive to strictly negative (in line with Proposition 1).[24] Because of the sharp adjustment in growth, moreover, the economy experiences strong scarring effects as output does not revert to its pre-shock trend after the crisis is over. This squares well with the empirical evidence that financial crises tend to followed by long-lasting drops in output (Cerra and Saxena, 2008; Aikman et al., 2022).

What is the take-away from the two experiments? One possible reading might be the following. While financial dominance implies that the central bank is behind the curve and the output gap is positive, those costs appear to be small compared to the gain of having avoided a huge debt crisis. It may thus be a good idea to follow such a "backstop rule" in practice. Indeed, as argued recently by Boissay et al. (forthcoming) and Akinci et al. (2021), central banks do seem to follow such backstop rules in practice. To cite from the former paper: "Our backstop rule speaks to the "backstop principle" that most central banks in advanced economies have de facto been following since the GFC and that consists in deviating from conventional ("normal times") monetary policy when necessary to restore credit market functionality."

In contrast to this positive notion, we will next use our model to point out an important caveat of following the backstop principle. We will show that it may open the door to multiple equilibria, in which the effects of financial dominance become much amplified.

4 The role of macroeconomic expectations

This section contains the main result from our paper. Again we study how the economy responds to a large negative supply shock, and how this depends on the monetary response to the shock. But now we show that - by following a backstop policy - the central bank may open the door to self-fulfilling beliefs by the private sector. When those beliefs kick in, the central bank effectively loses its control over inflation.

4.1 Strategic complementarity

To lay down our main result analytically, we first look at a simplified version of our model. We assume that, as long as the dividend is non-negative (which in equilibrium is always the case, because the central bank is assumed to follow a backstop policy), the growth rate is *exogenous*, and simply equal to its steady state value g.

The model then collapses to the following expressions. In any shock period $t \in \{0, ..., T\}$ (where

[24] Why is the negative output gap not associated with outright deflation? The reason is the endogenous decline in growth, which pushes up firms' marginal costs, sustaining inflation. Anzoategui et al. (2019) argue that this effect helps to understand the "missing deflation puzzle" in the post Global Financial Crisis period.

$T+1$ is the random date at which the shock reverts to the steady state), the Euler equation is

$$\frac{1}{c_t} = \beta R_t \frac{1}{g}\left(\frac{p}{c_{t+1}} + \frac{1-p}{c}\right), \tag{39}$$

where c_{t+1} is to be understood as conditional on the shock being still in place (when the shock disappears, which happens with probability $1-p$, consumption equals its steady state value c). The resource constraint is

$$\Psi z L_t = c_t + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}. \tag{40}$$

where recall $Z_t = z$ in the shock state. To simplify the algebra, here we have set the production fixed cost to zero ($\nu = 0$). Dividends are

$$d_t = \varpi z L_t + \frac{b_{t+1} g}{R_t} - b_t - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}, \tag{41}$$

and the borrowing constraint is, using that it always binds throughout the shock phase

$$b_{t+1} = \kappa \frac{\varpi L_t z}{g}. \tag{42}$$

We start by laying down the intuition for why equilibrium multiplicity is possible. The reason is a strategic complementarity between the behavior of the central bank and the behavior of firms. In a nutshell, the central bank keeps interest rates lower than otherwise when firms' debt is high, due to financial dominance. In turn, firms' borrowing choice depends inversely on the interest rate, i.e. it increases when the interest rate falls.

To see this in equations, we solve the Euler equation (39) forward, and insert the resulting expression in (40) and (42)

$$b_{t+1} = \frac{\kappa}{g}\frac{\varpi}{\Psi}\left[\frac{pc}{(1-p)\left(p\frac{R_t}{R} + p^2\frac{R_t R_{t+1}}{R^2} + p^3\frac{R_t R_{t+1} R_{t+2}}{R^3} + \ldots\right)} + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right], \tag{43}$$

where $\{R_t, R_{t+1}, \ldots\}$ is the interest rate path conditional on the shock being still in place (conditional on the shock reverting, instead, the interest rate is the steady state one R).

Equation (43) shows that firms' borrowing depends on the entire path of *expected* future interest rates. In fact, whenever expected real interest rates are lower, then debt levels will be larger. This is simply driven by the fact that the borrowing constraint depends on interest rate expectations through the output gap. Other borrowing constraints, for instance those which contain the price of capital (as in Bianchi and Mendoza, 2018) or the value of the firm, would also share this property that they become relaxed when interest rate expectations decline.[25]

It is now clear why equilibrium multiplicity might be possible in our model. One might imagine that interest rate expectations decline exogenously, keeping firms' borrowing high. Because the

[25] Similar dynamics emerge with defaultable debt (Bernanke et al., 1999), since declines in interest expectations lead to lower default risk enhancing firms' endogenous borrowing capacity.

central bank responds to more leverage by keeping interest rates low, such expectations could be self-fulfilling.

Like we do, Farhi and Tirole (2012) emphasize that a strategic complementarity between borrowing choice and central bank behavior may lead to multiple equilibria. They argue that self-fulfilling credit booms might be possible, in which private agents leverage up, in the anticipation of a future bailout through low interest rates (see also Diamond and Rajan (2012)). We focus on the same strategic complementarity, but emphasize another type of equilibrium multiplicity. In our setup, we impose that the economy is highly leveraged from the start. We then show that multiple ways exist in which inflationary shocks play out due to self-fulfilling beliefs of financial dominance.

4.2 Equilibrium with animal spirits

We focus on the simplified model from the previous section, and impose that the central bank follows the following "backstop rule".

Assumption 1 *In every shock period t, monetary policy sets R_t to minimize $|L_t - 1|$, subject to the constraint $d_t \geq 0$.*

In words, the central bank seeks to implement the natural allocation, unless doing so triggers a debt crisis.[26] As we argued before, such a backstop rule is arguably not a bad description of central bank behavior in practice (Boissay et al., forthcoming; Akinci et al., 2021). We show that following this rule opens the door to multiple equilibria when the shock is large and debt levels are initially high enough.

The equilibrium without animal spirits.

We start by solving for the equilibrium in the green dashed lines in Figure 2 in Section 3.2, which henceforth we will call the "good" financial dominance equilibrium. To repeat, this equilibrium has the following shape. The economy is initially in steady state, when the shock hits in period 0. In period 0, the central bank hikes the interest rate up to the level R^d, which is below the level R^n so that the output gap is strictly positive. From the second shock period onward, however, the central bank is able to close the output gap, because leverage has declined from the initial to the second shock period.

Using (39), from the second shock period onward, the central bank sets the interest rate

$$R^n = \frac{\frac{R}{c^n}}{\frac{p}{c^n} + \frac{1-p}{c}}, \tag{44}$$

[26] Due to monopolistic mark-ups and the usual growth externalities that characterize endogenous growth models (e.g., Aghion and Howitt, 1992), the natural allocation in our model is not efficient. Here we take the perspective that the central bank's goal is to eliminate the inefficient part of inflation (which it achieves by closing the output gap), rather than attempting to correct distortions which are unrelated to monetary policy. This being said, in Section 5 we show that our main results also apply to a setting in which the central bank sets the interest rate optimally under discretion.

where c^n is defined as

$$\Psi z = c^n + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}, \tag{45}$$

i.e. equation (40) when the output gap is closed ($L_t = 1$).

We have to make sure that, in the initial shock period, the central bank cannot set R^n as this would imply a negative dividend. Imposing $L_0 = 1$ and $R_0 = R^n$, and setting $d_0 < 0$ in equation (35), we get for initial leverage

$$b_0 > \varpi z \left(1 + \frac{\kappa}{R^n}\right) - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}. \tag{46}$$

That is, initial leverage must be large enough, or, for given initial leverage, the shock must be large enough (z must be sufficiently below 1). Throughout the paper, we assume that the economy is initially in steady state when the shock hits. Using that $b_0 = \kappa\varpi/g$ in steady state, we can write condition (46) as

$$\kappa > \frac{1}{\varpi}\left(\frac{1}{g} - \frac{z}{R^n}\right)^{-1}\left(\varpi z - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right), \tag{47}$$

which is now a condition on the leverage parameter κ. Intuitively, when condition (47) holds, the central bank cannot set R^n without triggering a negative dividend in the initial shock period once the economy starts from its steady state.

When condition (46) holds, the central bank sets $R_0 = R^d < R^n$, which is such that equation (41) solves exactly to zero. Using equations (39) and (40)

$$0 = \frac{\varpi}{\Psi}\left(\frac{g}{\beta R^d}\left(\frac{p}{c^n} + \frac{1-p}{c}\right)^{-1} + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right)\left(1 + \frac{\kappa}{R^d}\right) - b_0 - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}, \tag{48}$$

which defines $R_0 = R^d(b_0)$ implicitly. As we had argued before, R^d declines in b_0 because the central bank is more constrained when initial leverage is larger.

Finally, we need to ensure that the central bank is indeed able to close the output gap from the second shock period onward. This happens when b_1, which is implied by the central bank's actions in period 0, and is given by

$$b_1 = \frac{\kappa}{g}\frac{\varpi}{\Psi}\left(\frac{g}{\beta R^d(b_0)}\left(\frac{p}{c^n} + \frac{1-p}{c}\right)^{-1} + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right), \tag{49}$$

is below the threshold in equation (46).[27] As one can verify, this puts an upper bound on initial leverage b_0. The reason is that R^d is lower when b_0 is larger, which in turn increases b_1 because the borrowing constraint is relaxed when the central bank sets a lower interest rate. In summary, initial leverage must be large enough that the central bank is constrained in the first shock period (condition (46)), but it can also not be too large, for in this case the central bank would also be

[27] Equivalently, $R^d(b_1)$ must be larger than R^n.

constrained in the second shock period.[28]

Equilibrium with animal spirits.

The "good" financial dominance equilibrium described above rests on beliefs by the private sector that R^n will be implemented from the second shock period onward. That is, while the central bank cannot close the output gap in the first shock period, beliefs are that it will be able to do so from the second shock period onward. In fact, it is precisely those beliefs about rising interest rates going forward that reduce firms' new borrowing in the initial shock period. As we have just shown, such beliefs can be fully rational ex-post, because low leverage ex-post enables the central bank to raise interest rates eventually.

We now assume different beliefs by the private sector, which rest on a much stronger form of financial dominance. We assume the beliefs that the central bank cannot close the output gap for the *entire duration of the shock*, at least when debt levels are initially high enough. We show that such beliefs may also support an equilibrium under the monetary rule from Assumption 1.

Formally, we write these beliefs as follows. In every shock period t, beliefs conditional on the remaining shock periods $h \in \{t+1, ..., T\}$ are such that[29]

$$R_h = \begin{cases} R^a < R^n & \text{if } b_{t+1} \geq b^a \\ \min\{R^d(b_h), R^n\} & \text{if } b_{t+1} < b^a, \end{cases} \tag{50}$$

where the two numbers b^a and R^a (where"a" stands for animal spirits) are equilibrium objects. In words, when initial debt levels in the next period are high enough ($b_{t+1} > b^a$), the central bank will set the interest rate to the level R^a for the remainder of the duration of the shock. Because R^a is strictly below R^n, the output gap is strictly positive. In contrast, when $b_{t+1} < b^a$, we are back to normal, as agents expect the central bank to set interest rates as in the "good" financial dominance equilibrium (R^d or, when this is feasible, R^n).[30]

We now explain how the numbers R^a and b^a can be found. First, the beliefs by the private sector must be *self-sustaining*. This is the case when, conditional on the central bank actually implementing R^a in all shock periods, the resulting debt level is exactly b^a. Setting $R_t = R^a$ in equation (39), solving for consumption $c_t = c_{t+1}$ (which remains constant across shock periods when the central bank implements $R_t = R^a$ throughout), and plugging the result in equations (40) and (42), we obtain for b_{t+1}

$$b_{t+1} = \frac{\kappa}{g} \frac{\varpi}{\Psi} \left(\frac{\frac{g}{\beta R^a} - p}{1-p} c + \left(\frac{g - \rho}{\chi} \right)^{\frac{1}{\varphi}} \right) \equiv b^a, \tag{51}$$

[28] To be clear, this equilibrium also exists when b_1 is larger than the threshold in equation (46). In this case, the central bank would be constrained by corporate debt for multiple periods. However, our analytical results do no longer hold in this case, and the equilibrium must be computed numerically.

[29] Here, T denotes the last period of the shock, which is a random variable because the shock reverts with probability $1-p$ in every period.

[30] In addition, we assume the equilibrium selection that, whenever the beliefs $b_{t+1} > b^a$ can be supported, those beliefs will also be selected. Our focus is on showing that animal spirits are possible, not that they are inevitable.

so we impose that b_{t+1} equals exactly b^a. If b_{t+1} were below b^a, beliefs would be internally inconsistent, as the private sector would no longer expect the central bank to set R^a going forward (see the belief function (50)).[31] Intuitively, the debt level must remain high enough during the shock phase so that financial dominance does not disappear.

Second, confirming the beliefs by the private sector must be *ex-post optimal* for the central bank, i.e. in line with the backstop rule from Assumption 1. Assume that the economy enters shock period t with the debt level $b_t \geq b^a$. It is easy to see that setting the interest rate strictly below R^a cannot be optimal for the central bank, because this would make the output gap only more positive.[32] But what about setting $R_t > R^a$? To rule out this case, we set R^a to a level such that, once the central bank exceeds it, this will trigger a debt crisis.

By construction, if the central bank sets $R_t = R^a$, this leads to $b_{t+1} = b^a$ in the next period. If it sets $R_t > R^a$, this therefore leads to $b_{t+1} < b^a$. By the belief function (50), going to $b_{t+1} < b^a$ triggers a discrete change in agents' beliefs about what will happen in the remaining shock periods. Namely, agents now expect that the central bank will set interest rates from the "good" financial dominance equilibrium going forward. We have to make sure that this discrete change in agents' beliefs, which is associated with an upward jump in interest rate expectations, tightens financial conditions by enough such that a debt crisis is triggered.

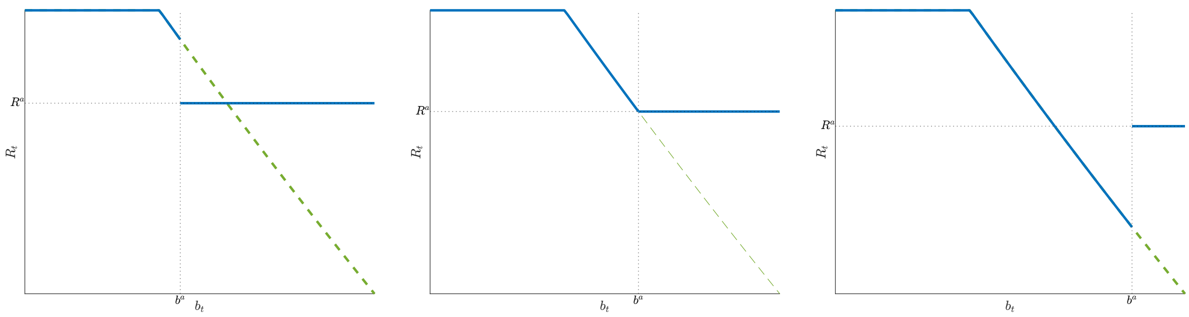
To understand when this happens, have a look at Figure 3, which shows agents' beliefs about R_t as a function of incoming debt b_t, for different combinations of (b^a, R^a) that are all consistent with equation (51). In the range $b_t < b^a$, the central bank is expected to set the interest rate from the "good" financial dominance equilibrium. This interest rate is first flat at R^n, and then declines in b_t, once debt levels are large enough so that $R^d(b_t) < R^n$. This goes on until the point $b_t = b^a$. From this point onward, the central bank is expected to implement R^a. Panel 3a shows a case where b^a is small and R^a is large. Panel 3c shows the opposite case where R^a is large and b^a is small. Finally, the middle panel 3b shows an intermediate case, where b^a is chosen such that it forms a continuous relationship with $R^d(b_t)$.

We now use this diagram to think about ex-post optimality of the central bank's action. First, panel 3a is not consistent with optimality. At the point $b_t = b^a$, the central bank can raise the interest rate above R^a without triggering a debt crisis. This is possible because $R^d(b^a)$ - which is the highest level of interest rates that still avoids the crisis (conditional on beliefs that the central bank follows the policy from the "good" financial dominance equilibrium going forward) - is strictly larger than R^a. Therefore, the central bank can raise the interest rate above R^a, at most to the point $R^d(b^a)$. The case $R^d(b^a) > R^a$ can therefore not be an equilibrium.

In panels 3b and 3c, instead, the central bank cannot raise the interest above R^a without triggering a debt crisis when $b_t \geq b^a$, because $R^d(b_t)$ is (weakly) below R^a in this range. Both of these cases therefore support the equilibria that we want to construct.

[31] In turn, if the debt level were above b^a, this would be inconsistent with optimality, as we argue below.

[32] Moreover, beliefs going forward would be unchanged, because by setting $R_t < R^a$, next period's debt level would be $b_{t+1} > b^a$. This also explains why the debt level from equation (51) cannot be strictly larger than b^a. In this case, the central bank could raise the interest rate above R^a and make the output gap smaller, and this would leave agents' beliefs unaffected as long as the resulting debt level still satisfies $b_{t+1} > b^a$.



(a) Inconsistent with optimality. **(b) Equilibrium.** **(c) Implausible beliefs.**

Figure 3: Constructing the equilibrium with self-fulfilling beliefs. Notes: Shown are beliefs about R_t against the level of incoming debt b_t, for different combinations of (b^a, R^a) that all satisfy equation (51). The figure is based on the simplified model, numbers are only for illustration.

From now on, we move forward only with the middle panel 3b which we deem the most plausible. In panel 3c, agents expect interest rates to be non-monotonic in b_t (first declining, then jumping up, then declining again). More appealing is a case where interest rate expectations are a (weakly) decreasing function of the debt level. This is the case in the middle panel. Nevertheless, the dynamics we analyze in the following would be similar under the beliefs shown in panel 3c.

To summarize, the second condition on (b^a, R^a) is that $R^d(b^a) = R^a$, which is the case depicted in the middle panel in Figure 3. Using equation (48), we get

$$0 = \frac{\varpi}{\Psi}\left(\frac{g}{\beta R^a}\left(\frac{p}{c^n} + \frac{1-p}{c}\right)^{-1} + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right)\left(1 + \frac{\kappa}{R^a}\right) - b^a - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}. \tag{52}$$

When (b^a, R^a) satisfies the two conditions (51)-(52), we have found an equilibrium.

Proposition 2 *An equilibrium with self-fulfilling beliefs exists and satisfies $R^a \geq R$ and $b^a \leq b$ when the following condition holds:*

$$\kappa > \frac{1}{\varpi}\left(\frac{1}{g} - \frac{\tilde{z}}{R}\right)^{-1}\left(\varpi\tilde{z} - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right), \tag{53}$$

where we define the auxiliary variable $\tilde{z} \equiv z + \left(\frac{R^n}{R} - 1\right)\frac{c^n}{\Psi} > z$.

Proposition 2 establishes a parametric condition such that a self-fulfilling equilibrium of the type constructed above exists (that is, equations (51)-(52) have an intersection). Moreover, the condition also ensures that the economy falls in this equilibrium once it starts from the steady state when the shock hits (because $b \geq b^a$, and so debt levels are initially above the critical debt level).[33] As it is intuitive, equilibrium multiplicity arises when the leverage parameter κ is large enough, that is, the economy must be able to support a lot of debt. Second, the crisis must be deep and persistent enough (z must be small enough, and p must be large enough). Intuitively,

[33] Another parametric condition ensures that dividends are non-negative in the equilibrium with animal spirits. However, this condition is very weak (it puts a mild upper bound on κ) and we only report it in the proof of the proposition in Appendix C.

the crisis must be expected to be persistent because the self-fulfilling mechanism works through "un-anchored" interest rate expectations (beliefs that interest rates are below R^n for as long as the shock persists).

It is instructive to compare condition (53) with condition (47). Recall the latter is the minimal κ so that the "good" financial dominance equilibrium exists. It is easy to see that the critical κ from condition (53) is strictly larger compared to the one in condition (47), because of $\tilde{z} > z$. We therefore have the following ranking. For low enough κ, financial dominance is never a concern. For higher levels of κ that exceed the threshold in (47), financial dominance starts to kick in, but equilibrium multiplicity is not yet possible. When κ is even higher, and exceeding the threshold in (53), then multiple equilibria start to be possible. We confirm this ranking in our numerical results below, where we study again the full model.

4.3 Self-fulfilling financial dominance in the full model

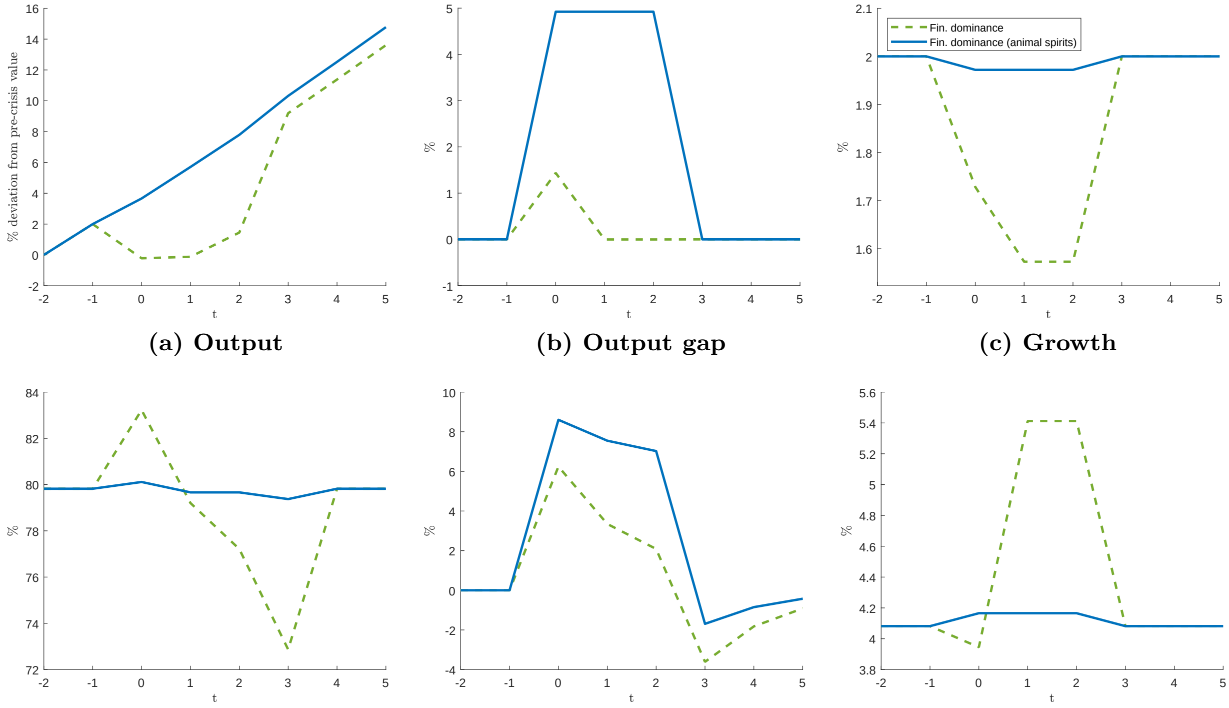
We go back to the full model from Section 2, where growth is fully endogenous. We show that the financial dominance equilibrium with animal spirits that we constructed in the previous section also exists in our full model, which we can only solve numerically. To do so, we use the calibration from Section 3.2.[34]

In the following figures, we use blue solid lines to depict the financial dominance equilibrium with animal spirits. Moreover, as in Figure 2, we use green dashed lines to depict the "good" financial dominance equilibrium, in which the central bank is able to close the output gap from the second shock period onward. Recall that both of these equilibria are consistent with the central bank's policy rule in Assumption 1, but they differ in terms of private sector beliefs.

Figure 4 has the same shape as Figure 2, but showing the two financial dominance equilibria. We can see that, in the equilibrium with animal spirits, the central bank effectively loses its control over inflation. In response to the shock, the central bank hikes only slightly on impact (to R^a, which is approximately 4.2% in this example), and remains stuck with this interest rate for the remainder of the duration of the shock. The reason is that the private sector *anticipates* this outcome, which lowers interest rate expectations, and keeps leverage in the economy high. Indeed we see that in this equilibrium, the corporate debt-to-GDP ratio hardly moves in response to the shock. The result is a much larger positive output gap compared to the other financial dominance equilibrium and, in consequence, a much sharper rise in inflation.

A naive observer could conclude that the central bank must not be behaving optimally, because the economy appears to be far away from the debt crisis region throughout the shock phase (output and therefore firms' profits are almost fully stabilized, and debt levels are not contracting), while at the same time the output gap is large and positive. Why not simply raise rates? What this overlooks is that by raising rates and forcing leverage down, the central bank would trigger a discrete change in agents' beliefs. Namely, interest expectations would jump upwards discreetly.

[34] Compared to Figure 2, we make the shock slightly larger. We show below, in Figure 5, how our results depend on the size of the shock.



(a) Output (b) Output gap (c) Growth

(d) Debt to GDP (e) Inflation (f) Real interest rate

Figure 4: Two financial dominance equilibria after negative supply shock.

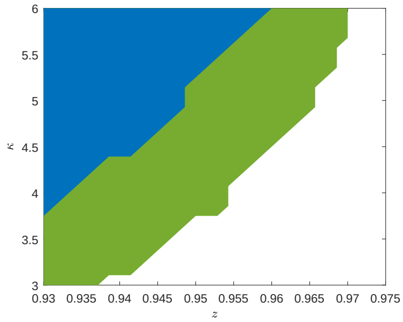
By construction, this change in beliefs would tighten borrowing conditions by enough such that a debt crisis is triggered, which the central bank correctly anticipates. This is the reason why, on the equilibrium path, the central bank accepts that the economy overheats.

Multiplicity zones.

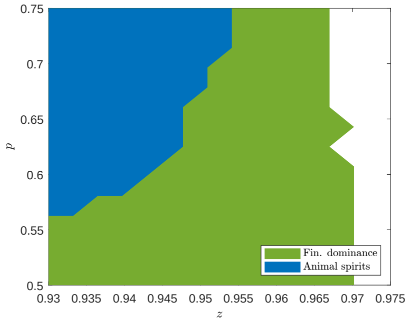
An interesting question to ask is over what range of parameters does the equilibrium with self-fulfilling beliefs exist. To answer this question, we solve the full model for a range of values of the leverage parameter κ, the shock size z, and the expected persistence of the shock p, and inspect numerically which equilibria are possible. As we showed in Proposition 2, those three are critical parameters for the existence of the equilibrium with animal spirits. The result is in Figure 5. In both panels, we put the shock size z on the horizontal axis. The left panel has κ on the vertical axis, the right panel has p on the vertical axis.

In white is the region where financial dominance is absent. In this region, the central bank can hike the interest rate freely to the level R^n and therefore close the ouput gap already in the initial shock period. Firms' profits decline as a result, but not by enough to push dividends to zero. As it is intuitive, this region prevails when the shock is small ($z > 0.97$, i.e. the supply shock is less than 3 percent) and when leverage in the economy is low (small κ).

The green region indicates the set of parameters where financial dominance arises, i.e. the central bank cannot raise the interest rate all the way to R^n in the initial shock period without triggering a debt crisis. In terms of our simple model, this region is the equivalent to condition (47). Importantly, in this region financial dominance arises, but the equilibrium with animal spirits



(a) Leverage



(b) Shock persistence

Figure 5: Financial dominance regions.

is not yet possible.

This brings us to the blue region. In this region, the equilibrium with animal spirits exists (in addition to the "good" financial dominance equilibrium, which also continues to exist). In terms of our simple model, this region is the equivalent to condition (53). We can see that the equilibrium with animal spirits exists only when leverage is particularly high, or when the shock is particularly large. Moreover, the shock must be expected to be persistent enough for this equilibrium to exist. All of these numerical results are consistent with our earlier analytical results in the context of the simplified model.

How does this map into actual corporate debt levels in the US economy prior to Covid? In our calibration above, we used a value $\kappa = 5$ in order to hit the very high corporate debt-to-GDP ratio observed in the US prior to Covid, of roughly 80% (recall Figure 1). From Figure 5, we see that with this value of κ the economy is within the region where, with a large and persistent enough shock, the financial dominance equilibrium with animal spirits is a possibility. In fact with this amount of leverage, a 5% shock with an expected persistence of 2-3 years would be needed to activate the multiplicity region.[35]

5 Robustness and extensions

5.1 Positive demand shocks

Our main analysis focuses on negative supply shocks as the trigger of inflationary pressure. Our motivation for this is empirical: Boissay et al. (2025) find that monetary tightenings may trigger financial stress after negative supply shocks, but not so after positive demand shocks. We now explore this state dependency with the help of our model.[36]

[35] Lian and Ma (2020) document that in the last few decades, the medium debt-to-earnings ratio of large U.S. firms which face earnings-based constraints has been around 3.5, with an interquartile range of 3 - 4.5. The pre-Covid period thus stands out as a time when the corporate debt-to-GDP ratio has been exceptionally large (FRB, 2019).

[36] In the inflationary phase of the Covid period, which serves as our motivating example, both negative supply shocks and positive demand shocks were likely at work. Guerrieri et al. (2022) and Bernanke and Blanchard (2025) emphasize the role of supply shocks, while Giannone and Primiceri (2024) argue that demand shocks have been important.

To introduce demand shocks, we adjust households' preferences (1) in the standard way. Namely, denoting the demand shock by ζ_t, households' utility becomes $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \zeta_t \log(C_t)$. This leads to a different Euler equation, which is now given by

$$\frac{\zeta_t}{c_t} = \beta R_t \frac{1}{g_{t+1}} \mathbb{E}_t \frac{\zeta_{t+1}}{c_{t+1}}. \tag{54}$$

Focusing again on a purely transitory shock, as we did in Section 3.1, we obtain for GDP after the shock

$$\Psi Z_t L_t - \nu = \zeta_t \frac{R}{R_t} \left(\rho + (g-\rho) \left(\frac{R}{R_t} \right)^{\frac{\varphi}{1-\varphi}} \right) \frac{c}{g} + \left(\frac{g-\rho}{\chi} \right)^{\frac{1}{\varphi}} \left(\frac{R}{R_t} \right)^{\frac{1}{1-\varphi}}, \tag{55}$$

which is the same as in equation (34), except that ζ_t appears positively in consumption demand. When the central bank looks through the demand shock and does not adjust its policy rate ($R_t = R$), GDP is now higher (and so too are firms' profits, which depend positively on GDP as we argued before). This is very different compared to negative supply shocks, where a policy of looking through implies that GDP and firms' profits are unchanged, as we showed in Section 3.

This also implies that, when the central bank tightens to offset the demand shock, this brings GDP and firms' profits back to the steady state level, whereas after a negative supply shock, the tightening induces GDP and firms' profits to fall. From this argument, it is easy to see why positive demand shocks cannot (easily) generate debt crises and financial dominance in our model, in line with the evidence.[37]

5.2 Optimal monetary policy

We have derived our main result - the existence of multiple financial dominance equilibria - by restricting monetary policy to follow the simple "backstop rule" from Assumption 1. As we said before, this rule is arguably not a bad description of actual central bank behavior (Boissay et al., forthcoming; Akinci et al., 2021). But what if the central bank behaves optimally, trying to maximize households' welfare, rather than simply following a mechanical rule?[38]

In Appendix D, we study a version of our model in which the central bank optimizes under discretion. In this model version, we also microfound the Phillips curve and households' labor supply, to be able to judge the welfare costs from positive output gaps and inflation. We have two results.

First we show that our main result from the paper - the existence of multiple equilibria - arises also under optimal policy. This result may not be surprising. Focusing on linear models, Blake

[37]While firms' profits remain in steady state once the central bank tightens to offset the positive demand shock, the higher interest rate still implies that borrowing becomes more expensive, which is a drag on firms' dividends. However, this effect is too weak quantitatively to generate debt crises in our calibrated model, at least for plausible shock sizes and parameters.

[38]We do not study optimal monetary policy in the main text for two reasons. First, it is much more complicated, and obtaining analytical insights is a daunting task. Second, as it is well known, endogenous growth models feature various externalities, making the laissez-faire rate of growth inefficient (Aghion and Howitt, 1992). An optimizing central bank would try to correct for those externalities, making the channels that we want to highlight harder to detect.

and Kirsanova (2012) show that models in which policy makers optimize under discretion can generate equilibrium multiplicity once strategic complementarities are present - as in our model.[39] Of course, the fact that the central bank cannot commit to its future action is important for this result. If the central bank could commit, it could simply rule out the equilibrium with animal spirits by announcing the interest rate path from the "good" financial dominance equilibrium, and this equilibrium would prevail.

Second, we can also look at the welfare ranking of the different equilibria. As expected, we find that the financial dominance equilibrium with animal spirits has lower welfare compared to the "good" financial dominance equilibrium, reflecting the more positive output gap and the higher rate of inflation. Moreover, both equilibria have higher welfare compared to letting a debt crisis erupt. This must be the case under optimal policy - if the debt crisis had higher welfare, then the financial dominance equilibria would not exist because the central bank would simply hike rates and trigger the debt crisis.

Our perspective is therefore that, while using a backstop approach delivers higher welfare ex-post compared to letting a crisis erupt - as also emphasized by Boissay et al. (forthcoming) - those welfare gains may be smaller than one might think, because the backstop approach also opens the door to multiple equilibria.[40]

5.3 Nominal debt

In the main text we assume that firms' debt is indexed to the price level, which makes the analysis simpler because it divorces the model's real side from the nominal side, once we frame the central bank as setting directly the real interest rate. In Appendix E, we solve the full model numerically assuming that firms issue nominal debt, and compare results with the real-debt version.

We show that the two financial dominance equilibria also exist when firms issue nominal debt. A difference relative to before is that the surprise inflation in the impact period of the shock reduces the real stock of debt (as in the data - see the steep decline in Figure 1 once inflation sets in). In the later phase of the shock, however, the higher inflation is priced into nominal rates, and high inflation does not anymore erode the real stock of debt. Because the equilibrium with animal spirits requires that debt levels stay above a critical threshold b^a, this makes this equilibrium harder to achieve in the model with nominal debt. This force is generally not strong enough, however, to rule out existence of this equilibrium altogether. For instance, in Appendix E, we show that the economy may still fall in this equilibrium, once debt levels when the shock hits are somewhat higher than the steady state.

[39] We also show that both financial dominance equilibria feature a belief structure that is Markovian - i.e. the equilibrium is Markov perfect - an equilibrium refinement that is often used in the literature.

[40] In addition, following the backstop principle ex-post may lead to more leverage ex-ante, as forward looking agents anticipate this behavior by the central bank and become less prudent. Once this "collective moral hazard" is taken into account (Farhi and Tirole, 2012), the overall welfare effect of following a backstop approach may well be negative.

6 Conclusion

We study monetary policy in a Keynesian growth model with financial frictions. We study a scenario where private debt levels are initially high, and the central bank cannot close the output gap after an inflationary supply shock as doing so would trigger a debt crisis. Put differently, the central bank is constrained by private debts in its ability to control inflation - so called financial dominance. A backstop principle, of tightening less forcefully, implies that inflation is not fully avoided, but at least a debt crisis does not erupt.

The main argument of the paper is to point out a caveat of adhering to a backstop principle, as it may expose the economy to multiple equilibria once the inflationary shock hits. The private sector may come to expect that the central bank cannot raise interest rates forcefully. When this happens, interest rate expectations are lower, which makes private leverage more persistent. Because financial dominance drags forward in time, the beliefs become self-fulfilling. In this equilibrium "with animal spirits", the inflation spell coming out of the supply shock is substantially amplified, and it is also more persistent.

The existence of the equilibrium with animal spirits does not necessarily imply that following a backstop policy is a bad idea. If the central bank triggers a debt crisis, it triggers a deep recession and welfare losses may be substantial due to scarring effects. It does imply, however, that relying on monetary policy to avoid debt crises may be more costly than previously thought, as it may lead to a substantial bout of additional inflation through an expectational channel.

What are the implications for policy? Our results imply that, when faced with high private sector leverage and an inflationary supply shock, influencing private-sector beliefs about future monetary policy becomes important for central banks. Indeed, by convincing agents that interest rates will be raised forcefully after an inflationary shock, the equilibrium with animal spirits can be ruled out. Interestingly, this reverses the usual logic of forward guidance, which is to convince agents that interest rates will stay low. But here we deal with an inflationary supply shock and a possible "effective upper bound" on interest rates, while in traditional forward guidance, the problem is weak demand, low inflation and the effective *lower* bound on interest rates (Eggertsson and Woodford, 2003).

In addition, other policy tools may become important. As we have shown, the equilibrium with animal spirits can only exist when κ, the leverage parameter determining firms' maximum debt-to-earnings ratio, is high enough. This parameter may be affected by macroprudential tools. We leave integrating macroprudential policy into our framework for future research.

Finally, while we have focused our analysis around corporate debt, other types of debt - both public and private - have also reached very high levels recently. We expect our results to be similar for other types of debt, once they constrain monetary policy in its ability to raise interest rates. This may hold, in particular, for public debt, giving a new perspective on "fiscal dominance" (see Kase et al. (2026) for some work on this topic). Applying our analysis to other types of debt is an interesting extension of our framework.

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A Optimal dividend decision

To derive the firm's first order condition for dividends subject to the non-differentiability at zero, we treat dividend payouts $D^+_{j,t}$ and equity issuance $D^-_{j,t}$ as separate choice variables. The firm maximizes

$$V_{j,t} = D^+_{j,t} + (1+\gamma)D^-_{j,t} + \beta\mathbb{E}_t\frac{C_t}{C_{t+1}}V_{j,t+1} \tag{56}$$

subject to the budget constraint

$$\begin{aligned} D^+_{j,t} + D^-_{j,t} = \varpi A_{j,t}Z_tL_t - \nu A_t - \tau\left(\varpi A_{j,t}Z_tL_t - \nu A_t - \left(1-\frac{1}{R_t}\right)B_{j,t+1}\right) \\ + \frac{B_{j,t+1}}{R_t} - B_{j,t} - I_{j,t} + T_{j,t}, \end{aligned} \tag{57}$$

the law of motion for firm productivity (10), and two inequality constraints with associated multipliers μ^+_t and μ^-_t

$$D^+_{j,t} \geq 0 \quad \text{and} \quad D^-_{j,t} \leq 0. \tag{58}$$

The first order conditions for $D^+_{j,t}$ and $D^-_{j,t}$ are

$$\lambda_{j,t} = 1 + \mu^+_t \quad \text{and} \quad \lambda_{j,t} = (1+\gamma) - \mu^-_t \tag{59}$$

It follows that

- $D^+_t > 0$ implies $\mu^+_t = 0$ and $\lambda_{j,t} = 1$. Then, $\mu^-_t = \gamma$, such that $D^-_{j,t} = 0$
- $D^-_{j,t} < 0$ implies $\lambda_{j,t} = (1+\gamma)$, so $\mu^+_t = \gamma$ and $D^+_t = 0$
- If $D^+_t = 0$ and $D^-_{j,t} = 0$, $\lambda_{j,t}$ can take any value in the interval $[1, 1+\gamma]$ and $\mu^+_t + \mu^-_t = \gamma$ holds.

In conclusion, it cannot be optimal to pay dividends and issue equity at the same time. It is possible that the firm does neither. Define the variable $D_{j,t} = D^+_{j,t} + D^-_{j,t}$, which contains all relevant information (i.e. from $D_{j,t}$, both $D^+_{j,t}$ and $D^-_{j,t}$ can be backed out). The equilibrium condition (15) for $\lambda_{j,t}$ follows immediately from the above.

B Proof of Proposition 1

As in the main text Section 3.1, we assume that the economy returns to the steady state in period 1. The equilibrium has two properties which we will use throughout the proof:

- $R^n(Z_0)$ is a strictly decreasing and continuous function. It is defined by equation (34) as the interest rate that implements $L_0 = 1$ without the equity issuance friction.
- Equilibrium outcomes for d_0, c_0 and g_1 only depend on Z_0 through R_0. Thus we can write $d(R_0)$, for example. Equilibrium outcomes also depend on b_0, but we suppress this dependence.

From these two properties, it follows that any variable that is increasing in Z_0 indirectly through R^n, i.e. $\frac{\partial x(R^n(Z_0))}{\partial Z_0} > 0$, must depend negatively on R_0, $\frac{\partial x(R_0)}{\partial R_0} < 0$ and vice versa.

Define the functions $d^+(R_0)$ and $g^+(R_0)$ as the outcomes of d_0 and g_1 in the absence of the equity issuance friction. That is, they are computed under the assumption $\lambda_0 = 1$, without imposing the equilibrium value of λ_0.

Prerequisites: Existence of Z^d and R^d.

Here, we show that for any initial debt level b_0, there exist values Z^d and $R^d = R^n(Z^d)$, such that $d(R^d) = 0$ and $\frac{\partial d_0^+}{\partial R_0}(R^d) < 0$.

If $Z_0 = 1$, dividends are positive in the natural allocation. We will show that there exists a value $\tilde{Z} < 1$, such that $d^+(R^n(\tilde{Z})) < 0$. Then we define $Z^d = \sup\{Z : \ d^+(R^n(Z)) < 0 \ \& \ Z \leq 1\}$. Because all functions that define d_0 are continuous in $R^n(Z_0)$ when $\lambda_0 = 1$, this implies $d^+(R^n(Z^d)) = 0$. By construction, Z^d defines R^d. The derivative $\frac{\partial d^+}{\partial R}(R^d) < 0$ follows from the fact that dividends must turn strictly negative for $R_0 > R^d$, by the definition of Z^d.

It thus only remains to show the existence of $\tilde{Z}$. The only complication arises, because dividends can, in principle, increase in the natural allocation if Z_0 declines. This is the case if investment drops faster than firm income. We show that this is not possible globally, as dividends would turn negative for small Z_0 even if investment were to drop to zero. In the final step, we show that, for any Z_0, equilibrium dividends are even smaller than in the zero-investment hypothetical, as investment is always positive.

Dividends in period 0 are:

$$d_0 = (\varpi L_0 Z_0 - \nu)\left(1 + \frac{\kappa}{R_0}\right) - b_0 - \left(\frac{g_1 - \rho}{\chi}\right)^{\frac{1}{\varphi}}. \tag{60}$$

Assume the hypothetical natural allocation $L_0 = 1$ with no investment ($g_1 = \rho$). It follows that $c_0 = \Psi Z_0 - \nu$ and $R_0 = \frac{\rho}{\beta}\frac{c}{\Psi Z_0 - \nu}$, which yields

$$\tilde{d}(Z_0) = (\varpi Z_0 - \nu)\left(1 + \kappa\frac{\beta}{\rho}\frac{\Psi Z - \nu}{c}\right) - b_0. \tag{61}$$

The function $\tilde{d}(Z_0)$ is equal to $-b_0$ at $\frac{\nu}{\varpi}$. It thus takes a negative value for any $b_0 > 0$.[41]

To complete the argument, notice that $g^+(R^n(Z_0)) > \rho$, because the return on investment diverges to infinity at ρ. This implies that consumption c_0 is smaller and the interest rate $R^n(Z_0)$ is higher than in the no-investment hypothetical. Both of these imply that dividends, conditional on $\lambda_0 = 1$ are smaller than in the hypothetical: $d^+(R^n(\tilde{Z})) < \tilde{d}(\tilde{Z}) < 0$. This shows that $\tilde{Z}$ exists, the set $\{Z : \ d^+(R^n(Z)) < 0 \ \& \ Z \leq 1\}$ is not empty, and therefore Z^d exists. Thus the proof of the preliminary results is complete.

Proof of the proposition.

We can now turn to the main statement of Proposition 1. The goal is to show that, if condition (37) holds and the central bank sets an interest rate $R^d + \epsilon$, no equilibrium with dividends

[41] This holds even when $\nu = 0$.

$d_0 \geq 0$ exists. This then implies that $d_0 < 0$ and $\lambda_0 = 1 + \gamma$ is the equilibrium outcome.

As we have established in the preliminaries above, setting $\lambda_0 = 1$ implies $d_0^+ < 0$ at $R^d + \epsilon$. Conversely, $d_0 > 0$ and $\lambda_0 = 1$ is not an equilibrium. Next, we rule out the case $d_0 = 0$ and $\lambda_0 \in (1, 1 + \gamma]$. For this, use the growth Euler equation (26) and notice that $\lambda_0 > 1$ implies that $g_1 < g^+(R^d + \epsilon)$. Intuitively, if the equity issuance constraint binds, the value of firms' internal funds rises and they reduce investment to avoid equity issuance. We will see that this is self-defeating in general equilibrium if condition (37) holds.

At $R_0 = R^d$, the response of d_0 with respect to g_1 in general equilibrium is:[42]

$$\frac{\partial d_0}{\partial g_1} = \frac{\varpi}{\Psi z}\left(1 + \kappa \frac{\beta}{R^d}\right)\left(\frac{c}{\beta R^d} + \frac{1}{\varphi\chi}\left(\frac{g_1 - \rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}}\right) - \frac{1}{\varphi\chi}\left(\frac{g_1 - \rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}} \tag{62}$$

Evaluating the derivative at $g_1 = g^d \equiv g(R^d)$ gives condition (37).

If the condition fails, the derivative is negative. In this case, we can construct an equilibrium for $R_0 = R^d + \epsilon$ with $d_0 = 0$, which is ϵ-close to the equilibrium at $R_0 = R^d$. To do so, we choose $g_1 = g^+(R^d + \epsilon) - \delta$, with δ large enough such that $d_0 = 0$. This is possible, because dividends are only marginally negative at $g_1 = g(R^d + \epsilon)$. By (26), $\lambda_0 > 1$ for $g_1 < g^+(R^d + \epsilon)$ so the remaining equilibrium condition is satisfied.

Now consider the converse case, in which (37) holds and the derivative of dividends with respect to growth is *positive*. Thus, as firms cut investment individually, general equilibrium feedback effects explained below dominate the positive effect on dividends. Here, reducing g_1 marginally below $g^+(R^d + \epsilon)$ further reduces dividends, so locally no equilibrium with $d_0 = 0$ can exist.

It remains to show that even globally, no equilibrium with $d_0 = 0$ exists, so that $d_0 < 0$ is the necessary outcome. This follows from the fact that a positive derivative $\frac{\partial d_0}{\partial g_1}$ at $g_1 = g^d$ implies that the derivative is positive for all $g_1 < g^d$. This is straightforward to see, by distinguishing two cases.

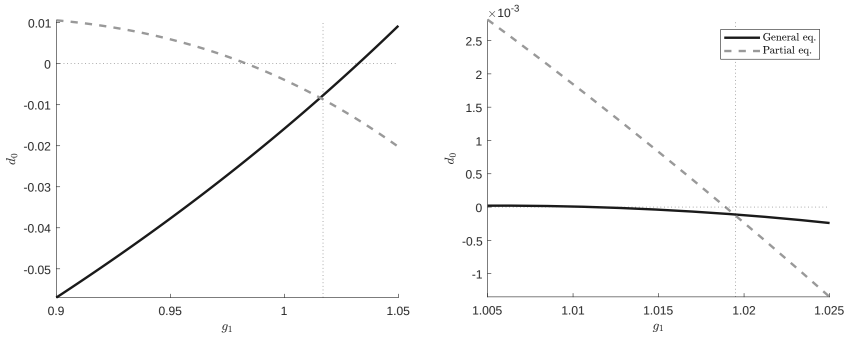
i) If $\frac{\varpi}{\Psi z}\left(1 + \kappa \frac{\beta}{R^d}\right) \geq 1$, it follows immediately that the derivative is negative for all g_1.

ii) If $\frac{\varpi}{\Psi z}\left(1 + \kappa \frac{\beta}{R^d}\right) < 1$, the second derivative $\frac{\partial^2 d_0}{\partial^2 g_1}$ is negative as it has the same sign as $-\left(1 - \frac{\varpi}{\Psi z}\left(1 + \kappa \frac{\beta}{R}\right)\right)$. This means the first derivative is decreasing in g_1. If it is positive at g^d, it must be positive at any smaller g_1 as well.

Finally, the equilibrium with $d_0 < 0$ exists and is straightforward to construct. We have $\lambda_0 = 1 + \kappa$, which can be used to solve for $g_1 < g^d$ from (26). We can also solve for the implied output gap in this equilibrium

$$\Psi z L_0 - \nu = \frac{R}{R^d}\left(\rho + (g - \rho)\left(\frac{1}{1+\gamma}\frac{R}{R^d}\right)^{\frac{\varphi}{1-\varphi}}\right)\frac{c}{g} + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\left(\frac{1}{1+\gamma}\frac{R}{R^d}\right)^{\frac{1}{1-\varphi}}.$$

[42]This derivative is obtained by fixing $R_0 = R^d$, combining all equilibrium conditions, except for the growth Euler equation (26), and then taking the total derivative under the assumption that the economy reaches the steady state in the next period.



(a) Condition (37) holds. **(b) Condition (37) fails.**

Figure 6: Growth and dividends in partial and general equilibrium.

This shows that $L_0 < 1$ when γ is large enough. ■

Economic interpretation of the proposition.

To get a better economic understanding of how a crisis plays out, we visualize the proposition. We follow Boissay et al. (forthcoming), who illustrate the financial crisis equilibrium in a similar manner, while their mechanism is very different.

Figure 6 shows the economy being hit by a shock $z < Z^d$ and the central bank responds by choosing R_0 marginally above R^d for two different parametrizations. In panel (a), we use our baseline parameters such that condition (37) holds. In (b) they are chosen so that the condition fails.[43]

Each panel plots firm dividends d_0 against the growth rate g_1. The black solid line is the general equilibrium response obtained by imposing all equilibrium conditions except for the growth Euler equation. The gray dashed line is the partial equilibrium response; it is computed by varying $g_{j,1} = \frac{A_{j,1}}{A_{j,0}}$ for an individual firm while holding all aggregate variables constant given the aggregate growth rate $g_1 = g^d$. Due to the one-to-one link between investment and growth, these figures can be read as dividends depending on firm investment. Since R_0 is (just) above R^d, dividends are negative at the point $g_1 = g^d$, where the partial and general equilibrium values coincide by construction.

Focus first on the right panel (b). The gray dashed line is downward sloping: a cut in firm investment, all else equal, allows the firm to pay higher dividends. Since the firm would have to finance its investment by issuing equity, optimal growth falls below g^d. In partial equilibrium, the firm would cut investment exactly until dividends are zero again, where the gray dashed line intersects zero. However, in general equilibrium, there is a feedback effect. Because all firms reduce dividends, demand for consumption and investment declines, and firm profits contact. This counteracts the rise in d_0 somewhat. In the aggregate, firms therefore need to cut investment more to achieve $d_0 = 0$, which is the new equilibrium point where the solid line is zero.[44]

Now turn to the panel (a). The logic behind the gray dashed line is the same as before. The lack of internal funds leads to a reduction in firm level investment until dividends are zero. However,

[43] This requires a quite extreme parameterization so the figure should be seen purely illustrative.
[44] It remains to verify that $\lambda_0 \in (1, 1+\gamma)$ at this point, which is straightforward to do.

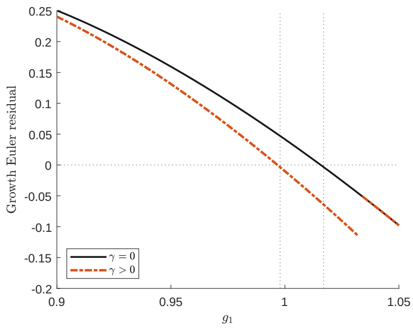


Figure 7: Growth Euler equation residual.

here the investment cut backfires in general equilibrium, where aggregate demand and firm profits contract so much that dividends turn even more negative. Firms cut investment even more, which feeds back negatively into dividends and so on.

When does this amplification stop? To answer this question consider Figure 7. The red dash-dotted line shows the residual in the growth Euler equation (26) evaluated for the parameters from panel (a) and $R_0 > R^d$, as before.[45] A positive residual indicates that the benefit of investment outweighs its cost. The jump in the residual occurs at the point where general equilibrium dividends turn negative and λ_0 increases from 1 to $1+\gamma$. For comparison the black solid line shows the same residual when $\gamma = 0$ and no jump occurs. We can thus see that the only point where the residual on the red dash-dotted line is equal to zero (vertical dashed line on the left) lies in the range where dividends are negative and growth is low. Economically, the amplification stops, when investment is so low (its return so high), that firms are willing to finance it through equity issuance.

C Proof of Proposition 2

To prove Proposition 2, we need to show that condition (53) is sufficient such that $R^a \in [R, R^n)$[46] and $b^a \leq b$ exist which solve (51) and (52).

To see this, we insert (51) into (52) by substituting out b^a to get

$$0 = \frac{\varpi}{\Psi}\left(\frac{R^n}{R^a}c^n + \Psi z - c^n\right)\left(1 + \frac{\kappa}{R^a}\right) - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}} - \frac{\kappa}{g}\frac{\varpi}{\Psi}\left(\frac{\frac{g}{\beta R^a} - p}{1-p}c + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}\right), \tag{63}$$

where we used equations (44) and (45). Equation (63) is a second-order polynomial in $(R^a)^{-1}$. Thus the proof of the proposition comes down to showing that the polynomial has a root in the relevant range, such that $R^a \in (R, R^n)$. A sufficient condition for this is that the sign of the polynomial value differs at the end points of the interval. This is what we show here.

[45] Again, all other period 0 equilibrium conditions are imposed and future variables are fixed to the steady state.

[46] R^a cannot be larger than R^n because then it would not constrain the central bank from implementing the good equilibrium. It cannot be smaller than R, because we want to make sure that $b^a < b$, so that the economy may fall in the equilibrium with animal spirits once it starts from the steady state.

First, insert $R^a = R$ to get

$$\frac{\varpi}{\Psi}\left(\frac{R^n}{R}c^n + \Psi z - c^n\right)\left(1 + \frac{\kappa}{R}\right) - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}} - \frac{\kappa\varpi}{g},$$

where we used that $g = \beta R$ and $c = \Psi - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}$. Condition (53) from the main text ensures that this is strictly negative.

Second, insert $R^a = R^n$ to get

$$\varpi z\left(1 + \frac{\kappa}{R^n}\right) - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}} - \frac{\kappa\varpi}{g}z,$$

wbere we use that $\frac{\frac{g}{\beta R^n} - p}{1-p}c = c^n$ (from (45)). We need to ensure that this is strictly positive, which holds as long as

$$\varpi z - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}} > \kappa\varpi z\left(\frac{1}{g} - \frac{1}{R^n}\right).$$

This condition is equivalent to the condition that, when the shock is z and the central bank sets R^n throughout the shock period, firms' dividends are positive.[47] This imposes a very weak upper bound on κ, and we assume that this is satisfied. ■

D Optimal monetary policy and microfounded Phillips curve

Here we show that the same dynamics, including equilibrium multiplicity, can arise also as Markov-perfect equilibria when the central bank sets the interest rate under discretion to maximize social welfare instead of following an ad-hoc backstop rule.

One change relative to our baseline model is that we need to microfound households' labor supply and the Phillips curve when we study optimal policy, to be able to judge the costs from an output gap and inflation. We hence introduce a labor dis-utility term in the households' objective as well as a wage Phillips curve, derived from purposeful wage setting by monopolistically competitive household-unions subject to Rotemberg (1982)-type adjustment costs.

Moreover, in what follows we focus on the simplified version of our model from Section 4, where growth remains in steady state conditional on firms' dividends being positive. This avoids that the central bank tries to influence growth in tranquil times, which it would do in our full model since the laissez-faire growth rate in that model is not efficient.[48,49] For this reason, studying optimal

[47] The left hand side captures firms' profits after investment at this point, and the right hand side captures the expenses on servicing the debt.

[48] In fact, the growth rate in our full model is inefficiently low from a social perspective, because of the classic growth externalities emphasized by the endogenous growth literature. For example, in the law of motion (10), firms build on the aggregate stock of knowledge when making their investment decision, not internalizing that they themselves contribute to the aggregate stock of knowledge.

[49] The laissez-faire outcome is inefficient also due to monopolistic mark-ups (in the intermediate good sector and the labor market), which implies that households work too little relative to first best. The central bank tries to correct for these distortions under optimal policy, causing an inflation bias. However, our main result of multiple equilibria still comes out transparently (see below), and hence we refrain from introducing subsidies to correct for

monetary policy in the full model would blur the channels that we want to highlight.[50]

In recursive notation and written in stationary form, the central bank target is[51]

$$W(b,Z) = \max_R \left\{ \log(c) + \frac{\beta}{1-\beta}\log(g) - \omega\frac{L^{1+\phi}}{1+\phi} - \frac{\theta}{2}\left(\frac{\Pi^W}{\bar{g}} - 1\right)^2 + \beta\mathbb{E}W(b',Z') \right\}, \tag{64}$$

which already imposes the Markov structure, by assuming that a time-invariant value function exists. The parameter $\phi > 0$ is the inverse Frisch elasticity of labor supply and $\omega > 0$ scales the labor disutility. The costs from adjusting nominal wages are dictated by the parameter $\theta > 0$. The constraints are given by equations (40)-(42) from the main text

$$\Psi ZL = c + \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}$$

$$d = \varpi ZL + \frac{b'g}{R} - b - \left(\frac{g-\rho}{\chi}\right)^{\frac{1}{\varphi}}$$

$$b' = \kappa\frac{\varpi LZ}{g},$$

the growth dynamics

$$g = \begin{cases} \bar{g} & \text{if } d \geq 0 \\ 1 & \text{if } d < 0, \end{cases} \tag{65}$$

as well as households' Euler equation

$$\frac{1}{c} = \beta\frac{R}{g}\mathbb{E}\frac{1}{\mathcal{C}(b',Z')}. \tag{66}$$

Two other implementability constraints are the dynamics of wage inflation and price inflation. Following the analysis in Fornaro and Wolf (2023), their Appendix D, we obtain for the wage Phillips curve[52]

$$\left(\frac{\Pi^W}{\bar{g}} - 1\right)\frac{\Pi^W}{\bar{g}} - \beta\mathbb{E}\frac{c}{c'}\left(\frac{\mathbf{\Pi}^W(b',Z')}{\bar{g}} - 1\right)\frac{\mathbf{\Pi}^W(b',Z')}{\bar{g}}$$
$$= \frac{\varepsilon}{\theta}L\left(\omega L^{\phi}c - \frac{\varepsilon-1}{\varepsilon}(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}Z\right). \tag{67}$$

those additional distortions.

[50] Another possibility would be to introduce a time-varying subsidy which makes investment efficient outside of a debt crisis and then analyze discretionary policy around this outcome, similar to Garga and Singh (2021). A downside of this approach, however, is that the resulting subsides are very large and the annual growth rate then exceeds 10% for typical parameterizations.

[51] Because of recursive notation in this section, we use $\bar{g}$ to denote steady state growth.

[52] To derive this Phillips curve, we assume that firms' labor demand is a composite of household labor types, given by $L_t = \left(\int_0^1 L_t(k)^{\frac{\varepsilon-1}{\varepsilon}}dk\right)^{\frac{\varepsilon}{\varepsilon-1}}$. The wage adjustment costs are $\frac{\theta}{2}A_tP_t\left(\frac{1}{g}\frac{W_t}{W_{t-1}} - 1\right)^2$. The adjustment cost is multiplied with A_tP_t to ensure the existence of a balanced growth path. Moreover, we assume that wage inflation is indexed to the growth rate of productivity in steady state, g. This ensures that households do not pay any wage adjustment costs in steady state.

Here we use $\Pi^W \equiv W/W^l$ to denote wage inflation with subscript l for the lag of a variable, and $\varepsilon > 1$ is the elasticity of substitution between household labor types. Price inflation then is

$$\Pi = \frac{Z^l}{Z}\frac{\Pi^W}{g}. \tag{68}$$

In equation (65) we assume that growth is in steady state as long as dividends are non-negative, as explained above. Moreover, we simply assume that growth declines to zero conditional on a crisis occurring ($g = 1$).

The key equation is the Euler equation (66), which contains the beliefs $\mathcal{C}(b', Z')$ by the private sector about consumption in the next period if the state of the economy is (b', Z'). The beliefs about future consumption capture the beliefs about future monetary policy, because by solving the Euler equation forward, consumption is a function only of future expected interest rates. Similarly, beliefs about future inflation $\mathbf{\Pi}^W(b', Z')$ are determined by beliefs about future output gaps, which in turn are determined by beliefs about future monetary policy.

As is standard in discretionary optimization problems, the central bank takes the functions $\mathcal{C}(b', Z')$ and $\mathbf{\Pi}^W(b', Z')$ as given when it optimizes, but taking into account how b' affects future outcomes by affecting its own future policy. Thus $\mathcal{C}(b', Z')$ and $\mathbf{\Pi}^W(b', Z')$ must be consistent with the central bank choosing optimally in all periods.

A Markov-perfect equilibrium consists of a central bank value function $W(b, Z)$ and policy function $R(b, Z)$, belief functions $\mathcal{C}(b', Z')$ and $\mathbf{\Pi}^W(b', Z')$, and a set of functions $\mathcal{F} = \{b'(b, Z, R)$, $c(b, Z, R)$, $L(b, Z, R)$, $d(b, Z, R)$, $g(b, Z, R), \Pi^W(b, Z, R), \Pi(b, Z, R)\}$ such that

i) The functions $\mathcal{F}$ satisfy all private equilibrium conditions for all (b, Z, R) and for the given beliefs.

ii) $R(b, Z)$ maximizes (64) for all Z and b for given beliefs and the functions $W(b', Z')$ and those in $\mathcal{F}$. Moreover $W(b, Z)$ satisfies the recursion (64).

iii) Beliefs are consistent with equilibrium outcomes for all states: $\mathcal{C}(b, Z) = c(b, Z, R(b, Z))$ and $\mathbf{\Pi}^W(b, Z) = \Pi^W(b, Z, R(b, Z))$.

Even though we focus on the simple model with exogenous growth, the equilibrium can only be studied numerically. For the numerical results we use the same parameters as in the main text. For the new parameters, we proceed as follows. First we set $\phi = 3$ and $\omega = 0.82$, the latter scaling $L = 1$ in steady state. We follow Fornaro and Wolf (2025) to calibrate the Phillips curve. We use $\varepsilon = 10$ for the elasticity of substitution between labor types. We set $\theta = 78$ to calibrate the slope of the Phillips curve. This value ensures that the Phillips curve has the same slope as a Calvo-type version of the Phillips curve with an average wage duration of three quarters, as Fornaro and Wolf (2025) show. We focus on the same shock structure as in the main text: the economy is hit by a supply shock $z = 0.95$ initially, which persists with probability $p = 0.7$, and the economy moves

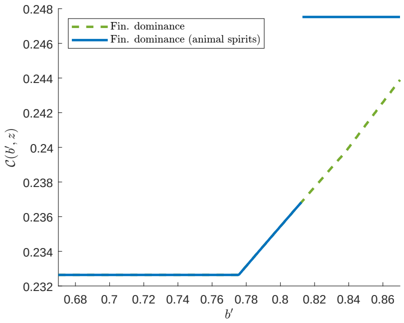


Figure 8: Belief functions under optimal policy.

back to steady state with probability $1 - p$.[53]

Our goal is to show (numerically) that belief functions $\mathcal{C}(b, Z)$ and $\mathbf{\Pi}^W(b, Z)$ exist that support the two financial dominance equilibria that we have studied in the main text. That is, multiple Markov-perfect equilibria are possible under optimal policy, indexed by different private sector belief functions.

Figure 8 shows the result. In this figure, we hold constant $Z = z$ at the shock state, and plot beliefs about consumption next period $\mathcal{C}$ against incoming debt next period b'. When debt levels are small enough, agents expect consumption to be independent of b'. In this region, financial dominance does not arise. When b' rises further, agents expect future consumption to be higher. This reflects that the central bank in the future is expected to be constrained by the debt level, leading it to keep interest rates lower than otherwise, which pushes consumption up. When debt levels rise even further, moreover, two equilibria become possible. In the financial dominance equilibrium with animal spirits (blue solid), consumption is expected to jump upward discreetly. This is because the central is expected to keep interest rates low for as long as the shock persists, in line with our arguments in the main text.

Figure 9 shows the policy functions for the interest rate R and new borrowing b' that are supported by the belief function in Figure 8. Again we hold fixed $Z = z$, and plot the policy functions against the incoming level of debt b.

We can see that, over the range $b < b^a$, the two equilibria coincide. In turn, once $b \geq b^a$, the equilibrium with animal spirits features a discrete upward jump of b', which leads to a second intersection with the 45 degree line. This shows that debt levels remain stuck at b^a once $b \geq b^a$

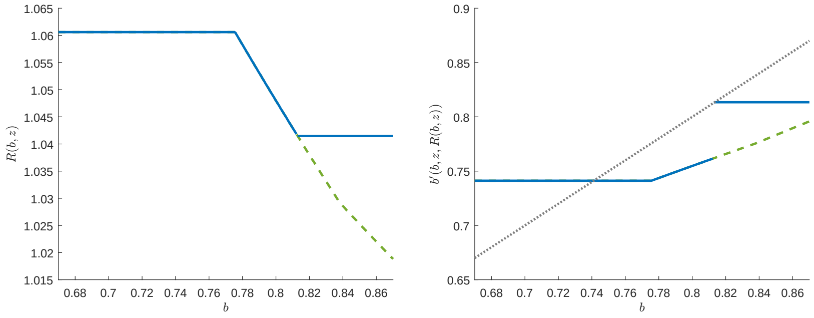
[53] As an aside, up to first order our Phillips curve is

$$\hat{\pi}_t^w = \beta \mathbb{E}_t \hat{\pi}_{t+1}^w + \frac{\varepsilon - 1}{\theta}(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}(1+\phi)\hat{L}_t \equiv \beta \mathbb{E}_t \hat{\pi}_{t+1}^w + \kappa \hat{L}_t,$$

where a hat above a variable denotes log-deviation from steady state (see Fornaro and Wolf (2025) for a derivation, here we also use the approximation $\hat{c}_t \approx \hat{Z}_t + \hat{L}_t$, i.e. that investment in innovation and the production fixed cost are small). Under our parameters, we get $\kappa \approx 0.2$ for the slope of the Phillips curve. Inserting our shock structure, we can write

$$\hat{\pi}_t^w = \frac{\kappa}{1 - \beta p}\hat{L}_t \equiv \tilde{\kappa}\hat{L}_t,$$

where we use that the output gap is closed and therefore that wage inflation is zero once the shock dissipates, and that the output gap is the same conditional on the shock persisting to the next period. The slope of the Phillips curve is now given by $\tilde{\kappa} \approx 0.65$, which is the value that we use in the main text to calibrate the slope of the reduced-form Phillips curve, that has no forward-looking component.



(a) Interest rate **(b) New borrowing**

Figure 9: Policy functions under optimal policy.

initially. The interest rate, in turn, flattens out at the point b^a (to the level R^a), while in the "good" financial dominance equilibrium, it declines further in b. How can new borrowing be lower in the "good" equilibrium, even though the interest rate is lower, over the range $b \geq b^a$? Of course, the reason is that interest rates move over time to R^n, the anticipation of which keeps borrowing low. In contrast, in the equilibrium with animal spirits, agents expect that R^a prevails during the entire duration of the shock. This explains that b' is strictly larger in this equilibrium over the range $b \geq b^a$.

Finally, we can use the model with optimal policy to look at welfare, which we do in Figure 10. Here we plot the value function W, again keeping the shock at $Z = z$, against the level of incoming debt b. As expected, welfare is decreasing in b in the region where the central bank is constrained by the debt level (because the positive output gap and wage inflation in this region is costly). Moreover, when debt levels are high enough and the equilibrium with animal spirits materializes, welfare experiences a discrete further decline. This is a reflection of the fact that the output gap is even more positive and inflation is even higher under this equilibrium, and both are expected to stay high for as long as the shock persists.

The red dashed-dotted line shows welfare under the debt crisis, which is below welfare in the two financial dominance equilibria. Thus while the financial dominance equilibrium with animal spirits is more costly than the "good" financial dominance equilibrium, even more costly would be to "break" expectations and trigger the debt crisis by raising interest rates further. In equilibrium, this must always be the case once the central bank optimizes for the financial dominance equilibria to exist. If being financially dominated were less costly compared to experiencing a debt crisis, the central bank would trigger the debt crisis in equilibrium and financial dominance equilibria would not be possible.

E Nominal debt

We now assume that firms issue nominal debt to households, rather than real debt as in the main text. When debt is nominal, inflation dynamics matter for the real allocation (the block structure from our baseline model breaks down). This implies that modeling inflation carefully becomes

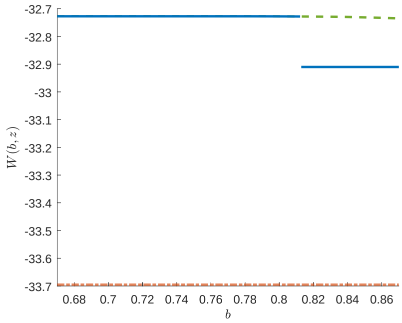


Figure 10: Welfare under optimal policy. Notes: welfare conditional on the debt crisis erupting is the red dashed-dotted line.

important. We therefore no longer use the reduced-form wage Phillips curve from the main text, but rather the same microfounded wage Phillips curve as in Appendix D. We do not derive the entire equilibrium here, but simply state the equilibrium conditions.

Letting i_t denote the net nominal interest rate, household optimization implies

$$\frac{1}{c_t} = \beta \frac{R_t}{g_{t+1}} \mathbb{E}_t \frac{1}{c_{t+1}} \tag{69}$$

as well as

$$1 + i_t = R_t \frac{\mathbb{E}_t \frac{1}{c_{t+1}}}{\mathbb{E}_t \frac{1}{c_{t+1}} \frac{1}{\Pi_{t+1}}}, \tag{70}$$

the latter linking the real interest rate to the nominal one and expected inflation (the Fisher equation).

With nominal debt, real dividends paid by firms are

$$d_t = \varpi Z_t L_t - \nu + \frac{\tilde{b}_{t+1} g_{t+1}}{P_t(1+i_t)} - \frac{\tilde{b}_t}{P_{t-1}} \frac{1}{\Pi_t} - \left(\frac{g_{t+1} - \rho}{\chi} \right)^{\frac{1}{\varphi}}, \tag{71}$$

where we denote $\tilde{b}_{t+1}$ nominal debt scaled by productivity. Notice that the state variable in the model with nominal debt is $\tilde{b}_t / P_{t-1}$. i.e. incoming debt scaled by last period's price level. The borrowing constraint is the same as in Drechsel (2023). Using that it always binds in our experiments

$$\frac{\tilde{b}_{t+1}}{P_t(1+i_t)} = \kappa \frac{\varpi L_t Z_t - \nu}{g_{t+1}}. \tag{72}$$

Firms' first order condition for borrowing is

$$\frac{1 + \tau i_t}{1 + i_t} = \beta \mathbb{E}_t \frac{c_t}{g_{t+1} c_{t+1}} \frac{1}{\Pi_{t+1}} + \frac{\iota_t}{1 + i_t}, \tag{73}$$

which pins down the multiplier on the borrowing constraint ι_t, again using that the borrowing constraint always binds in our experiments. The investment first order condition is identical to equation (26) in the main text

$$
\begin{aligned}
&\left(\frac{g_{t+1}-\rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}}\frac{1}{\varphi\chi}\lambda_t \\
&=\mathbb{E}_t\beta\frac{c_t}{g_{t+1}c_{t+1}}\left(\lambda_{t+1}\left((1-\tau)\varpi Z_{t+1}L_{t+1}+\rho\left(\frac{g_{t+2}-\rho}{\chi}\right)^{\frac{1-\varphi}{\varphi}}\frac{1}{\varphi\chi}\right)+\iota_{t+1}\kappa\varpi Z_{t+1}L_{t+1}\right). \quad (74)
\end{aligned}
$$

The wage Phillips curve is, as in Appendix D

$$
\left(\frac{\Pi_t^W}{g}-1\right)\frac{\Pi_t^W}{g}-\beta\mathbb{E}_t\frac{c_t}{c_{t+1}}\left(\frac{\Pi_{t+1}^W}{g}-1\right)\frac{\Pi_{t+1}^W}{g}=\frac{\varepsilon}{\theta}L_t\left(\omega L_t^{\phi}c_t-\frac{\varepsilon-1}{\varepsilon}(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}Z_t\right). \quad (75)
$$

Price inflation is given by

$$
\Pi_t=\frac{Z_{t-1}}{Z_t}\frac{\Pi_t^W}{g_t}. \quad (76)
$$

Finally the model is closed with the resource constraint

$$
\Psi Z_tL_t-\nu=c_t+\left(\frac{g_{t+1}-\rho}{\chi}\right)^{\frac{1}{\varphi}}. \quad (77)
$$

In equilibrium, financial crises are always avoided under the monetary rule we study. The equity issuance constraint is therefore slack at all times, implying that $\lambda_t=1$ for all t.

An equilibrium consists of real allocations $\{\tilde{b}_{t+1},g_{t+1},c_t,L_t,d_t,R_t\}_t$ and prices $\{P_t,W_t\}$ which satisfy these eight conditions, for given monetary policy $\{i_t\}_t$ and the supply shock series $\{Z_t\}_t$.

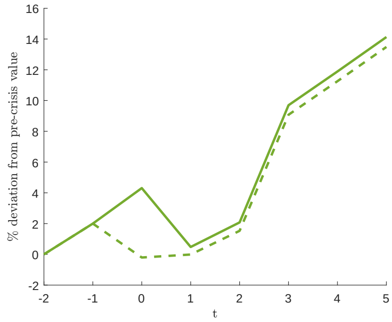
As in the main text, we specify monetary policy as following a backstop rule. It minimizes the output gap, subject to the constraint that the dividend is non-negative

Assumption 2 *In every period, monetary policy sets i_t to minimize $|\omega L_t^{\phi}c_t-\frac{\varepsilon-1}{\varepsilon}(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}Z_t|$, subject to the constraint $d_t\geq 0$.*

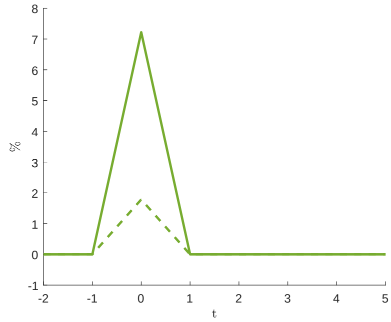
We proceed by contrasting results between this model and the corresponding version with real debt. For the numerical results we use the same parameters as in the main text (and Appendix D for labor dis-utility and the Phillips curve). Also the experiment is the same as before: the economy is hit by a previously unexpected negative supply shock, which materializes in period 0 and disappears again in period 3.

Figure 11 contrasts example transitions of the model with nominal debt (solid lines) and real debt (dashed lines) for the "good" financial dominance equilibrium. Figure 12 repeats this exercise for the equilibrium with animal spirits. The first insight is that both equilibria are still possible with nominal debt, and they look qualitatively the same as in a model with real debt.

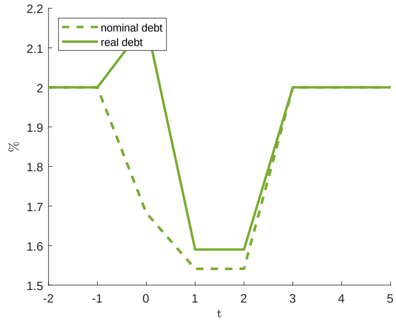
However, there are also some important differences. In the "good" financial dominance equilibrium (Figure 11) the real interest rate must decline sharply on impact, if debt is in real terms. In contrast, there is only a slight dip in the real rate in the economy with nominal debt. The reason is the bout of surprise inflation caused by the supply shock on impact, which devalues the



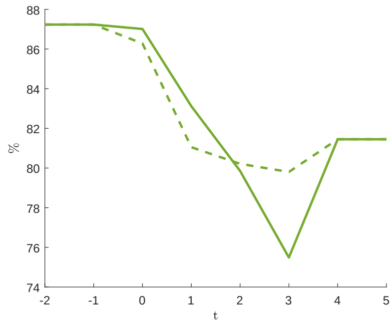
(a) Output



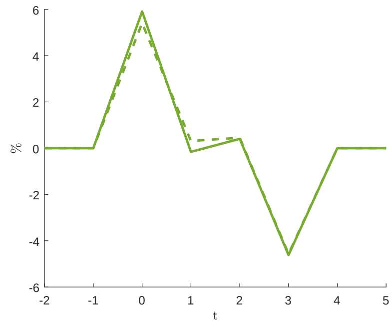
(b) Output gap



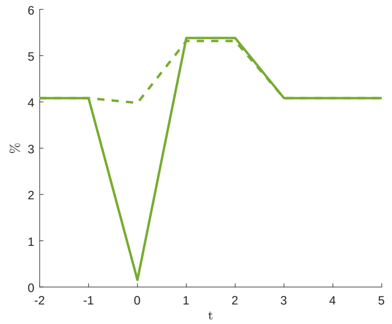
(c) Growth



(d) Debt to GDP



(e) Inflation

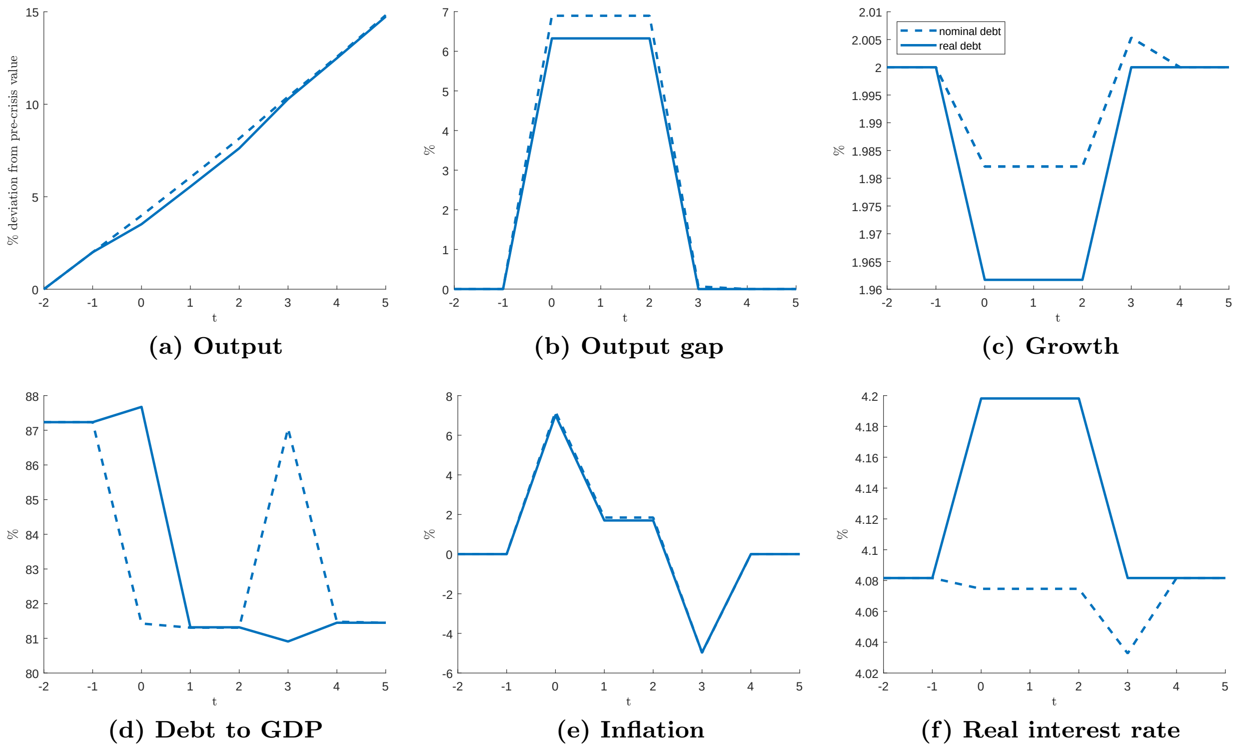


(f) Real interest rate

Figure 11: “Good” financial dominance equilibrium after negative supply shock, contrasting nominal and real debt.

outstanding nominal debt in real terms and thereby cushions the fall in firm profits. Thus debt to GDP declines slightly, even though output contracts. This implies that financial dominance is generally less severe with nominal debt, at least when contractionary shocks are inflationary. In fact, to be able to generate financial dominance in the model with nominal debt (i.e. that the central bank cannot close the output gap on impact), in the figure we initialize the economy at a debt-to-GDP level 5 percentage points *above* the steady state.

Does the inflationary effect of supply shocks then imply that the equilibrium with animal spirits becomes harder to sustain? Figure 12 shows that this is not the case. If debt is nominal, inflation directly reduces the value of outstanding debt when the shock hits, while animal spirits imply that output grows steadily. Thus debt to GDP immediately drops sharply. However, the central bank is still cornered with financial dominance. The reason is that breaking the inflationary expectations would immediately push *up* the real value of outstanding debts, due to a surprise dis-inflation, and trigger a debt crisis. This makes the central bank reluctant to break expectations, and makes it sustain the equilibrium with animal spirits. The importance of this classic Fisherian debt-deflation channel can be seen in the period when the supply shock disappears (period 3). Here debt to GDP is pushed upwards, as the period-3 expected inflation which was priced into period-2 nominal interest rates did not materialize ex post. As a result, the central bank needs to cut the interest rate (slightly) below the natural level in period 3, to shield firms from the deflationary effect of the improvement in productivity.



(a) Output **(b) Output gap** **(c) Growth**

(d) Debt to GDP **(e) Inflation** **(f) Real interest rate**

Figure 12: Financial dominance equilibrium with animal spirits, contrasting nominal and real debt.